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The tonnage on the New York State canals for 1892 will probably be somewhat less than in 1891, and below any year since 1860, as is shown by the following table, which indicates the highest and lowest points in the traffic for the period named:

Total tons carried in	1860			4,650,214
" " "	1872			6,673,370
" " "	1875			4,172,129
" " "	1885			4,731,784
" " "	1886			6,457,656
" " "	1890			5,246,102
" " "	to Oct. 21,	1891		3,627,828
" " "	to Oct. 21,	1892		3,379,118

About five weeks of the open season yet remain to be accounted for in this year; but the officials at Albany say that with the same average carried out, the total traffic for 1892 can not reach 4,000,000 tons.

The first large quadruple expansion engine to be built in this country has just been undertaken by the Dixon Manufacturing Co., of Scranton, Pa., for the Edison Electric Illuminating Co., of New York City. It is to use steam at 210 lbs. pressure and is rated at 2,500 HP. The cylinder diameters are 26, 37, 52 and 72 ins., with 36-in. stroke, and the speed will be 100 revs. per minute, or 600 ft. piston speed. The engine will be of the vertical inverted type, with the cylinders arranged in two tandem pairs and the cranks 90° apart. The dynamo to be run by this engine will be built up on the main shaft and will in fact form the fly wheel of the machine. The designers of the engine are Messrs. J. Van Vleck, of the Edison Co., and J. W. Sargent, of the Dixon Mfg. Co.

The new sewerage system for the city of Budapest, Hungary, has been completed. This improvement has been demanded for some years, as the old system had become inadequate to provide for the large increase in population of the last ten years. The new system has a capacity of 3 gallons of rainwater per hectar (2.47 acres) per second, and 4.17 gallons of sewage per capita per day. The population assumed is 500 per 2.47 acres. As the level of the city is but little above that of the Danube River, the sewage has to be pumped into the river. For this purpose 12 centrifugal pumps, with 3¼-ft. suction pipes, are used.

Work on the Corinth ship canal, which was resumed in 1890 by the new French company, is making rapid progress, only a small portion of the excavation remaining to be completed. The canal is about 4 miles long, with a center cut across the isthmus averaging 190 ft. deep for 2½ miles. Owing to the slips of canal sides developed in the original excavation, it was found necessary to construct retaining walls for nearly its whole length. The ground water met with in the excavation was pumped into intersecting drainage canals. The time stipulated for the completion of the canal is placed at Dec. 1, 1894, but owing to the favorable progress of work it will probably be completed some time in 1893.

The most serious railway accident of the week was a derailment Oct. 25 at Phillipsburg, Mo., on the St. Louis & San Francisco Ry., caused, it is reported, by a broken rail. The engine and mail and express cars passed safely, but the baggage and smoking car and two chair cars were derailed and went down the embankment. The rear sleepers kept the track. Two men were killed and about 16 injured, but none seriously.—A serious rear collision occurred Oct. 24 between Elkhart and Plymouth, Wis., on the Chicago, Milwaukee & St. Paul R. R., in which two men were killed, three very seriously injured and three others injured but not seriously. A construction train had sent out a flagman, but either he failed to do his duty or the signal was not seen, and the freight train ran into the caboose of the construction train. The engine and several cars were damaged.

A very serious rear collision occurred in England, Nov. 2, between the second section of an East Coast express train from Edinburgh to London, and a freight train, near Thirsk, Yorkshire. The signals were obscured by a thick fog, and the express ran into the freight train. Several cars were wrecked, and many of the passengers were unable to get out except through the windows, owing to the doors of the compartments being locked. The wreck caught fire from escaping gas, as reported, which is a similar experience to that of another English accident some weeks ago, when a gas reservoir on a wrecked car caused the burning up of the car. In the Thirsk accident about 10 persons were killed and 30 injured, 12 of the latter being seriously injured.

About thirty feet of a trestle on the Amboy Division of the Pennsylvania R. R., spanning the wreck at Yardville, near Bordentown, N. J., was burned Oct. 29. The fire was started by coals dropped from the engine of a freight train.

The state ownership of railways was the subject of a recent lecture in London, by Mr. W. M. Acworth, the well known writer on railway affairs. The question, he said, had not attracted the attention which it deserved, for it must occupy a prominent position in the program of practical politics of the not very distant future. He contended that a government railway must naturally tend to inertia. The railway companies were employers of 6% of the workmen of this country, and did anyone wish to see 350,000 more votes put into the hands of political parties? The defenders of the state system frequently pointed to the post office as an example of state control, but the post office management was the simplest thing in the world. They might perform their work very well, but the railways did it for them. He thought that in the country districts the service was uncommonly bad. It could not be inferred that the management of the state would be superior to the management of the private concern. The study of the railway history of the world for the last half century afforded no ground for the belief that it had, in fact, proved superior to private control. Public opinion, intelligent and organized, is in England almost a monopoly, and can even compel a railway company to enter on a path of reform and innovation at the risk of its dividend. But public opinion might not be strong enough to extort reform from a government department, which to every demand for improvement could reply that it would quickly consent if it were compatible with the interest of the public purse, of which it is the guardian, but that in the existing position of the public revenue the proposed improvement was, unfortunately, out of the question. He was fully persuaded that while the railway companies had done much for the country, there was much more that they might do, and in this he was most certainly correct, as we have more than once pointed out. He would rather rely on public opinion to improve the railway service of any district than he would call in the aid of any state official, from whose interference he would at best expect the maintenance of a dull and unvarying mediocrity.

An underground electric railway is to be built in London, between Moorgate St., on the Metropolitan Ry., and Finsbury Park, on the Great Northern Ry. Co.'s suburban line. The engineers are Sir Douglas Fox, Mr. Francis Fox and Mr. J. H. Greathead. The land valuation is estimated at $2,000,000, and the whole cost of construction in the neighborhood of $6,000,000. The authorized capital is $7,500,000, and the official name is the Great Northern & City Ry. Co. The length of the line will be three miles, and it will taken ten minutes to make a trip. The Greathead method will be used, with two tunnels at a depth of 50 ft. Elevators accommodating 100 people will be built at each station. Trains will run on a headway of three minutes during the busy hours.

The new Chicago lake tunnel is not ready for use, though the time has elapsed for its delivery to the city in working order, says the "Inter-Ocean." About 13,000 ft. of the tunnel has to be cleaned, and the contractor says this will require three weeks time at least. The breakage of the 30-million pump at Chicago Ave. makes it especially desirable that the tunnel work be hastened.

Proposals for works in connection with the construction of the commercial port of Bourgas will be received until Dec. 2 at the Hydraulic Service Department of the Ministry of Finance, Sophia, Bulgaria. The work includes hydraulic works estimated to cost $1,013,000, and a grain warehouse, $477,360. Plans, estimates, specifications, forms of tender, etc., may be seen at the Department, or may be obtained upon application and remitting $5 to J. N. Woultchoff, General Secretary.

The cost of railway cars in France is given in published particulars of the new rolling stock ordered by the French railways for the present half year. The Eastern Railway has ordered 10 first class cars costing $2,190 each, and 85 costing $1,930 each, 100 baggage cars at $593, and 150 freight cars of 22,400 lbs. capacity at $728, 100 at $518 and 250 at $385 each. The company has also ordered 1,500 sets of wheels at $14 each. The Northern Railway will build 9 first class cars and 1,100 freight cars of 22,400 lbs. capacity.

The relations between one of the principal railways in France and its 23,000 employees have been given in a report upon the relations between capital and labor in France. Not only the employees of the company, but their wives, families and relatives, have privileges upon a carefully graduated scale. The nominal wages are very low according to English standards, but they are supplemented by an elaborate system of bonuses carried out with singular minuteness. For example, an engineman gets an allowance for any coal he may save out of the normal consumption of his engine, and, if he accidentally has to work a little longer than his proper time, his coal saving is secured to him by an allowance of so much per minute. There are innumerable details of this sort involving a minuteness of account-keeping which Englishmen or Americans would scarcely be troubled with, but suiting the genius of a nation accustomed to small economies. The system is based upon the principal of rewarding excellence of service, providing collective advantages for employees, and giving precedence to the claims of their children for employment.

The Street Cleaning Department of New York has had appropriated to it, for 1893, the sum of $2,190,089. This includes a 5% increase in sweepers, drivers and hostlers. This total is an increase of $97,000 over 1892, and is divided as follows: Administration, $107,000; sweeping, $813,323; carting, $669,766; removing snow and ice, $40,000; final disposition, $290,000; new stock, $160,000; rentals and contingencies, $50,000.

The hub and shaft of the cable-wheel for the new power-house of the Broadway cable road weighs about 40 tons. It was hauled this week by 26 horses from the foot of Thirty-ninth St. to its destination and sadly damaged the street over which it passed, depressing the pavement in some places nearly one foot. The load was about 10 tons per wheel. This does not speak well for our pavements. Some time ago a reel of wire cable was hauled over the new telford pavements of St. Louis, imposing a load of nearly 14 tons per wheel, without any depressing of the surface. Both loads were excessive ones, but the St. Louis experience shows what can be done by properly preparing the foundation for a street surface.

The Niagara Falls power tunnel is to be extended 500 ft. and the contract is let to A. C. Douglass and G. M. Johnson. This extension is designed to bring into use for power purposes land along the river near Schlosser's Dock. It is to be completed by Feb. 1, 1893. On Oct. 29 a rise of 12 ft. in the Niagara River entered the portal of the tunnel and drove out the workmen. Much damage was done to derricks, etc., by the same flood on the Canadian power tunnel at the wheel pits.

The two proposed East River bridges to connect New York and Brooklyn are now under examination by a board of U. S. Engineers as to their allowable height above water. Mr. Uhlman, the president of the bridge company, says that if these bridges must be over 135 ft. above the water, or higher than the present Brooklyn bridge, the whole scheme will be abandoned, as to increase the height means a lengthening of the approaches and more land required. He estimated that it would cost $30,000,000 to build the two bridges together, or $32,000,000 to build them separately.

Compound locomotives are to be tried on the Bombay, Baroda & Central India Ry., and the company has advertised in England for proposals for their construction.

THE DRAINAGE OF THE KANKAKEE MARSH.

Because the arable lands once owned by the General Government are practically all taken up, and because the opening of each new Indian reservation to settlers is the signal for a mad stampede by thousands of people to grab for a share of the new territory, many people are under the impression that the area of cultivated lands in this country has about reached the maximum limit. But while it is true that one cannot now, as a few years ago, secure a fertile prairie farm for nothing, there are millions of acres of land still lying idle which only await the work of the engineer to be ready for the use of the farmer; and in many instances these lands will far surpass in productiveness the lands which were first taken up. The case reminds one of the experiences of the early settlers of portions of New England, who cleared first the uplands, which were covered with easily cut soft wood timber. It was not until these comparatively barren hillsides had been made into farms that attention was turned to the lands along the river bottoms where great elms and other hard wood trees made clearing very difficult, but where the deep rich soil recompensed well for the greater labor.

Concerning the vast possibilities of irrigation the public is now pretty well informed, but the quiet work which is being done in several States in the drainage and reclamation of swamp lands has attracted little attention. With the possible exception of Florida, the States of Illinois and Indiana have done the greatest amount of work in land drainage. Large tracts in both these States which were formerly impenetrable marshes, of no value whatever, are now yielding as good crops as the best prairie, and their value is far above the cost of their reclamation.

While many of these drainage enterprises are carried on without the assistance of engineers (and some have suffered shipwreck thereby), many others are of such magnitude as to require engineering skill of no mean order.

Among these is the proposed drainage of the Kankakee swamp, in Indiana, a tract of land half as large as the state of Rhode Island. The proposed drainage of this swamp is a matter of special importance just now, since the Kankakee River, which drains it, unites with the Des Plaines to form the Illinois River only a short distance below the mouth of Chicago's great drainage canal just put under way. The present swamp forms practically a storage reservoir for the river and maintains its flow at a very steady rate. The drainage and cultivation of the swamp will change this and will both decrease the dry weather flow of the river and greatly raise its flood stage. The latter especially is of importance in view of the increased flow through the Illinois Valley which will be caused by the Chicago drainage canal.

At the last meeting of the Indiana Engineering Society, an extended description of the Kankakee swamp and the plans for its drainage was given by Mr. W. M. Whitten, of South Bend, Ind., state engineer of the Kankakee River Improvement. From this we abstract the following particulars of the work.

The Kankakee marsh extends nearly half way across the northern portion of Indiana and contains about 400,000 acres; nearly 2% of the total area of the state. The head of the marsh is near the city of South Bend, and it extends thence west for about 80 miles, ending a few miles across the state line at Momence, Ill. The Kankakee River flows through the marsh with a broad, shallow and winding channel; a careful survey in 1871 showed over 2,000 bends between South Bend and Momence, and the total distance by the channel of the river between these points is 240 miles.

On each side of the river the marsh extends as a broad smooth plain, from 1 to 20 miles in width, its edge well defined by sand ridges. The whole marsh has a regular slope toward the west of about 1.3 ft. per mile, and over the upper part of the marsh it slopes also toward the river; over the lower part of the marsh, on the north side there is no slope toward the river, and the banks of the river are higher than the marsh back from the river.

Except along the river bank and on occasional small sand islands the marsh is destitute of timber; but coarse prairie grass, wild rice, and weeds grow in the greatest luxuriance in all parts of the marsh and even in the bed of the river itself. Indeed, the highest water of the year is frequently caused by the rank growth of grass in the channel of the river during the summer. The soil is a rich vegetable loam and the river flows over a bed of sand and fine gravel. No stone occurs to obstruct the work of dredging and ditching from South Bend to Momence, Ill., where the river flows over a limestone ledge.

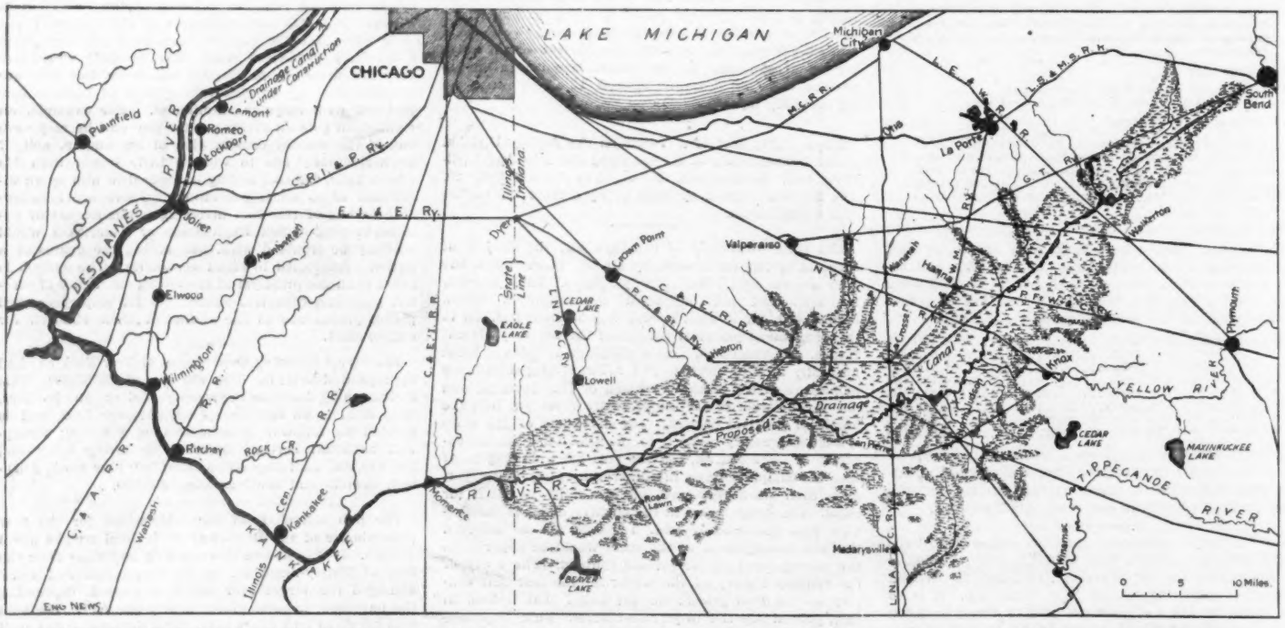
The whole tract of land included in the Kankakee swamp was granted by the General Government to the state of Indiana on condition that the proceeds from its sale should be applied to its drainage. This intention has never been carried out, and no action was taken looking to the reclamation of the whole tract until 1869, when a drainage law was passed by the Legislature, and under its provisions the Kankakee Drainage Co. was organized.

This company made surveys, located drainage channels and propose to straighten the river through the swamp by dredging a new channel. By the terms of its charter it was empowered to make assessments on the lands benefited or supposed to be benefited by the improvement. The landowners had generally understood that assessments of a dollar to a dollar and a half per acre would be sufficient for the work, and when assessments as high as $10 to $15 per acre were levied there was a universal protest. The courts of some counties set aside the assessments as invalid and the whole scheme fell to the ground. The operations of the company aroused such an enmity among the landowners that public opinion, which before had been strongly in favor of the draining the swamp, was turned against it. Some claimed that the whole swamp would burn up if it were drained, while others contended that it was useless for agriculture and would grow up to weeds if drained so that the parts where farmers had been accustomed to cut wild hay would lose what little value they had. Nevertheless, the small portions of the swamp which have been drained by private enterprise have proved highly productive. It is manifestly impossible to drain any large portion of the swamp except by united action, and the attempts of isolated landholders to drain their holdings, have in many cases been failures.

In 1881 a new law was passed by the Indiana Legislature providing for a report on the drainage of the swamp by "a competent and skillful civil engineer." Prof. John L. Campbell, of Wabash College, was appointed to this work and after making surveys reported in favor of excavating a new straight channel for the river through the swamp. The following is quoted from his report:

The drainage and recovery of the Kankakee marshes will include: First, the construction of a better main channel than now exists, for the flow of the river; secondly, the straightening and deepening of the beds of the streams which empty into the main stream; and thirdly, the digging of a large number of lateral ditches through the swamps to the improved channels. The portion of the work which seems properly to belong to state and national supervision is the improvement of the main channel of the river. The other parts of the work may be left to the owners of the land, to be executed under our general drainage laws.

Two streams, the Kankakee and Grapevine Creeks, unite nine miles from South Bend, and form the Kankakee River. This junction seems to be the proper place for the beginning of the improvement under state supervision. The approximate length of the river in the state from this initial point is 200 miles, as measured along the crooked channel, and the average fall per mile is less than 4 ins. The velocity of the stream is nearly uniform, and is about 1½ miles per hour, or 1.2 ft. per second. The general declivity of



MAP OF THE KANKAKEE RIVER SHOWING KANKAKEE MARSH AND ROUTE OF CHICAGO DRAINAGE CANAL ALONG THE DES PLAINES RIVER.

the marsh through which the river flows is 1.3 ft. per mile.

It is proposed to reduce the length of the river by the improvement, so that the distance from the initial point to Momence, Ill., will not exceed 85 miles, and the average fall per mile will be increased to more than 12 ins.

The dimensions of the proposed channel at the source or junction of Grapevine Creek with the Kankakee were as follows: Width of bottom, 27 ft.; at top, 45 ft.; depth, 6 ft.; sectional area, 216 sq. ft.; mean hydraulic depth, 4.26 ft.; mean velocity, 2.105 ft. per second; fall per mile, 1 ft.; discharge, 455 cu. ft. per second. From these dimensions the channel increases to the following at the state line: Width at bottom, 42 ft.; width at top, 69 ft.; depth, 9 ft.; mean hydraulic depth, 6.00 ft.; mean velocity, 2.7 ft.; discharge, 1,358.6 cu. ft. per second. The estimated cost of the entire work, at 10 cts. per cu. yd. for earth work, was $642,457.

The report further recommended that the improvement be continued onward from the state line to the rock ledge at Momence and that a portion of the rock in the channel at that point be removed to give a better outlet for the sand brought down by the increased current in the channel above.

The importance of the removal of this rock has been greatly exaggerated in the popular mind, and it came to be regarded as the key to the drainage of the entire Kankakee Valley. This is perhaps the reason why the Legislature, although it took no steps toward securing the excavation of the new channel, finally appropriated in 1889 the sum of $40,000 for excavating a channel in the rock at Momence. Commissioners were appointed to take charge of the work and Mr. W. M. Whitten was appointed Chief Engineer. Surveys were made for a channel 100 ft. wide and 7½ ft. deep extending a distance of 8,649 ft., with a flood channel of double the width. The total amount of rock excavation was 112,990 cu. yds. When proposals were called for in July, 1890, there were three bidders and only one was within the limit of the appropriation. This bidder, however, failed to furnish the required bond and so new proposals had to be called for.

The case is further complicated by the fact that a dam is maintained across the river at the head of the proposed rock channel by the Chicago & Eastern Illinois R. R. Its purpose is to set back the water and provide facilities for pleasure boating. A picnic resort is maintained at this point by the railway and frequent excursions visit it. The railway claims that the impairment of the boating facilities by the removal of the dam would injure it from $20,000 to $30,000 per annum. The right of the railway to maintain the dam is being contested in the courts, and until this is decided the fate of the river improvement at this point is uncertain.*

The important point made by Mr. Whitten in his paper was that the removal of the rock at this point, while desirable, was far from being essential to the drainage of the Kankakee marsh. He computed that the effect of the rock excavation would be to lower the surface of the water in dry weather only 2.15 ft. and in floods only 1.34 ft. So slight a reduction at this point would affect the level at the state line, 8 miles above, very little. The removal of the rock and of the artificial dams is indeed important for the reclamation of the marsh lands immediately adjacent, but it can have little effect on that portion of the swamp in Indiana.

The remainder of Mr. Whitten's paper was devoted to a discussion of the plan for the drainage of the marsh prepared by Prof. Campbell, described above. The dimensions of the channel proposed by Prof. Campbell would barely be sufficient to take care of the ordinary flow of the river, and would be wholly inadequate to cope with floods. Considering the fact that the surface of the water in the river must be considerably below the surface of the marsh in order to reduce the level of the ground water, with the further fact that drainage will largely increase the flood volume of the river, Mr. Whitten concludes that the proposed channel would have to be as much as ten times as large as that planned, which would make its cost prohibitory.**

In place, therefore, of the plan recommended by Prof. Campbell, Mr. Whitten would leave the present channel intact, merely clearing out the drift and cutting off a few bends. At a distance from the channel far enough back to give an ample cross-section for flood discharge, he would run dikes, thus preventing floods from overflowing the marsh. Along the edges of the swamp he would construct large catch drains or perhaps dikes to prevent the water from higher lands reaching the marsh. The enclosed lands of the marsh he would then drain by dredge ditches running in the general direction of the slope, which it will be remembered is about 1.3 ft. per mile toward the west.

We quote as follows the advantages claimed by Mr. Whitten for his plan compared with the "single channel" plan, which has been heretofore the one to which chief attention has been paid:

1. A very large reduction in the cost of construction, an exact estimate of which would require a detailed examination of the ground, but it is safe to say that, whether the work contemplated be a partial or a complete reclamation, the cost will be very largely reduced, and that complete drainage under this system will cost much less than partial drainage under the other system.

2. It admits of a perfect recovery of these lands, which can not be said to be entirely practicable by the other.

3. It does away with the difficulty of controlling the large volume of water that would necessarily be concentrated in a large straight channel, which, with the fall it would have, would certainly attain a velocity inconsistent with stability in the loose sand through which it would pass. The cost of maintenance would therefore be correspondingly reduced.

4. This method would leave the lands in a very favorable condition to take advantage of the water flowing through the valley for the purpose of irrigation. This will not generally be considered of any importance, as the only object heretofore sought has been to get rid of the surplus water of this region. If, however, no provision be made to utilize the surplus for the use of crops during droughts, these lands will suffer like all others for moisture in such seasons. The frequency with which entire failure of some crops occurs, and the fact that nearly every year crops are cut short by lack of rain at a critical period of their growth, are beginning to attract attention to the importance of preventing these enormous losses, and steps are even now being taken to put irrigation into practical operation in some localities in this state. The tendency toward intensified farming, and the fact that irrigation will double the yield of many crops, and greatly increase all, will eventually largely enhance the value of all lands that can, with reasonable outlay, be brought under its influence. If the value of the lands of this valley, which are so favorably situated to receive irrigation, be estimated by the crops they are capable of producing, it is probable that irrigation would add as much to the value of these lands when drained, as the drainage would add to the present value. The reservoirs provided might be found to equalize the flow to an extent that would effect a considerable saving in cost of dikes and ditches, while their surfaces would evaporate large quantities of water to moisten the surrounding atmosphere and mitigate the effect of droughts, and some of them at least would afford excellent facilities for the propagation of large quantities of fish.

5. This method renders the removal of the rock ledge at Momence of little importance, as the quantity of sand brought down would be much diminished and the reduction of water surface at the ledge less important than if the digging method were carried out, so that if the railroad company succeeds in its efforts to prevent the removal of the dams, the improvement of the marshes could still be accomplished without difficulty.

* Since Mr. Whitten's paper was read the Appellate Court has decided in favor of the Chicago & Eastern Illinois Ry. Co., in the case above referred to, and consequently nothing has been done toward the removal of the rock at Momence. If the railway company demands a sum for the relinquishment of its rights proportionate to the benefit which it claims to be receiving ($20,000 to $30,000 per annum), it is quite unlikely that the contemplated rock removal will be carried out at all, or at least for many years to come. Mr. Whitten's demonstration that this is not at all essential to the reclamation of the main body of the marsh becomes therefore of great importance.

** In justice to Prof. Campbell, it should be said that the plan presented by him in his report made ten years ago contemplated the general straightening of the channel along the line of the present river bed, except on the section between the Pittsburg, Ft. Wayne & Chicago crossing and the Louisville, New Albany & Chicago crossing, where an entirely new course for the channel was recommended. The accompanying map drawn from one published in his report shows the proposed deviation. To keep the work within practicable limits of cost, he did not design it of sufficient capacity to carry off floods.

THE AUTOMATIC SURFACE CATTLE GUARD.

The use of surface cattle guards to keep cattle from getting onto railway tracks at grade crossings is becoming more and more general, superseding the old pit cattle guards into which animals occasionally fell and were struck by trains. Several of these surface guards have been illustrated and described in our columns, and most of them are of the slat pattern, sometimes with devices intended to hurt the foot of any animal attempting to walk over the guard. An exception to this pattern, however, was the sewer pipe guard (Eng. News, March 28, 1891), which consisted of a paving of earthenware pipes set vertically.

THE AUTOMATIC SURFACE CATTLEGUARD.

We illustrate this week a novel and ingenious form of surface guard, invented by Mr. James Walton and Mr. G. D. Hutchinson, general foreman of the Chicago, Fort Madison & Des Moines Ry. As will be seen by the drawing, the animals must step on the swinging planks, and by their weight cause the row of prongs to rise up in front.

Longitudinal Section of Cattleguard.

frightening them and effectually barring their passage. Two of these guards were tried on the Chicago, Fort Madison & Des Moines Ry., and proved so satisfactory that six more were ordered in August. For the drawings and photograph we are indebted to Mr. Shnable, formerly Chief Engineer of the road, who writes as follows respecting the guard:

I had two of these guards placed in the track last March, at two points where stock had been daily walking across the wooden slat surface guard, supported at the ends. This automatic guard turned stock without a single failure; and we found it impossible to whip a stock buyer's pony across. Since these guards were put in they have required no repairs or attention. The leverage is adjusted so that cattle and horses, by stepping on the plank furthest from the prongs will raise them, and sheep and hogs will raise them by stepping on the plank nearest to the prongs. The triangular pieces are spiked on the ties (as shown) to compel the animals to step on the movable plank.

The ½-in. steel prongs have a shoulder, pass through the cross bar, are threaded and tightened with a nut, thus permitting a section man to take out any prong, should it become bent, and straighten it.

UNIFORM PRACTICE IN PILE DRIVING.

II.

The discussion of Mr. Crowell's paper was opened by Mr. A. M. Wellington, as follows:

As the author of the formula which Mr. Crowell has been good enough to select as on the whole the most convenient, perhaps I ought to open this discussion; but I must do so more briefly than I should wish, in order to cover duly all points to be considered, as what I have to say would perhaps be more appropriate in the form of a separate paper than in the form of a discussion.

I should premise that in any formula in regard to pile-driving, it must be assumed that the piles are driven under rational conditions, so that they are neither so heavily struck and so neglected in respect to sawing off broomed heads as to be battered and broomed unreasonably at the time the last few blows are given, nor so lightly struck that the blow does no work. It must always be assumed, too, that the pile has been sinking with reasonable regularity under the last few blows, and that the behavior of the pile when driving, and of the other piles around it, has been such as to give reasonable assurance that the apparent uniformity of set is not deceptive, i. e., that the pile is not really on the point of breaking through a thin crust into a semi-fluid substratum, or anything of that kind. Difficulties of that kind must be guarded against by the judgment and experience of the engineer, or not at all. Formulas cannot attempt to provide for them, but, fortunately, they are the exception.

The formula to which Mr. Crowell gives the preference was originally published in Engineering News of Dec. 29, 1888, in connection with an extensive discussion of the whole subject, and in comparison with 16 other formulas. It was there given in the form

$$L = \frac{2wh}{s+1}$$

in which L = "the safe working load for piles under all ordinary conditions, to be reduced under exceptional conditions (as notably with irregular penetrations), but never exceeded unless the pile is known to rest on rock and act as a column"; w = the weight of the hammer in pounds; h = the height of fall in feet, and s = penetration under the last blow in inches, "assumed to be sensible, and at an approximately uniform rate."

This formula was put forward as a purely empirical one, and its usefulness established only by comparing its results with known instances of resistance, and with the indications of other formulas, but, as a matter of fact, it was not purely empirical by any means; on the contrary, the general form,

$$L = \frac{fwh}{s+c}$$

was first deduced as the correct form for a theoretically perfect equation of the bearing power of piles, barring some trifling and negligible elements to be noted; and I claim in regard to that general form that it includes in proper relation to each other every constant which ought to enter into such a theoretically perfect practical formula, and that it cannot be modified by making it more complex, as Mr. Crowell proposes, or by making it less complex, without making it less correct and trustworthy as well as less convenient. The numerous formulas by such high authorities as Weisbach, Rankine, Sanders, Nystrom and many others, which contain from four to six other constants or variables, and have much more complex forms, I claim to be not only practically unsuitable, and for the most part, untrustworthy, but theoretically erroneous; not, of course, in their mathematical work, which I should not venture to question, but in their practical premises. This position I shall not now attempt to establish affirmatively, otherwise than by summarizing the process by which my own formula was deduced, which I believe to leave no gaps open for correction by more minute work. An error of judgment which has unnecessarily and greatly complicated many of the formulas is dealing with the energy of the blow in terms of weight multiplied by velocity, instead of foot-pounds of work.

In any case of pile-driving by blows, the work done is represented by the product of weight of hammer multiplied by height of fall = wh. There is a small loss from air resistance and friction in the guides, but this is infinitesimal with vertical guides, and is universally neglected. Mr. Crowell suggests determining this loss by chronograph observations, but it would be a waste of time. Even with a 30-ft. fall the striking velocity is only 30.1 miles per hour; the mean air resistance to the hammer is two to four lbs., and the loss therefrom merely equivalent to so much off the weight of the hammer, or about 1 part in 1,000. As for friction, that is always a function of pressure, and though the hammer itself is heavy, it can never press with much force against the vertical guides, which it loosely fits, if all is in good order. Even if the guides are not quite vertical, the loss must be small, except in some rare cases when the guides are purposely set much inclined in order to drive inclined piles. Such cases are exceptions not now considered, for which a proper special allowance can be made by the engineer.

All these foot-pounds of energy, wh, then, barring this universally and justly neglected fractional loss, are expended somehow during the set s of the pile, so that the mean resistance in pounds to the hammer during that set is expressed by $\frac{wh}{s}$

If h be in feet, however, and s in inches, this formula takes the form

$$\frac{12wh}{s}$$

Now, the energy of the blow may be absorbed in any or all of these five ways, which we will severally consider:

1. In brooming and mashing the pile, either (a) visibly on the head, or (b) invisibly at the foot of the pile, or even in its middle, which latter is far from uncommon.

2. In bouncing, and thus striking two or more light blows instead of one heavy one.

3. In compressing elastically the material of the pile and hammer.

4. In overcoming the inertia of the pile and the static grip of the earth upon it.

5. In causing the pile to penetrate against the surrounding earth's resistance.

1 (a). Brooming of the head is an enormous source of loss of work, whenever it occurs, both directly and in cushioning the blow. Some such brooming almost always occurs. The recognized remedy against this, however, and an entirely effective one, is to saw off the broomed part, and give a fresh solid surface for the blow, when the pile is nearly home. Don J. Whittemore, M. Am. Soc. C. E., contributed a paper to this Society some years ago, giving the results of some most valuable observations on this head, which should be studied in this connection.

1 (b). Brooming at the foot does not diminish the energy of the blow on the pile, but merely dissipates it unproductively. It can generally, but not always, be detected by the skilled pile-driver by a change in the behavior of the hammer and pile. No formula does or can provide against it. The judgment of the engineer and his assistants must be relied on to detect its probable or actual occurrence, and to act accordingly by stopping the pile-driving after brooming has begun. If all these precautions be taken, brooming will not occur to any injurious extent to any considerable number of piles. Therefore, no formula does or can make any allowance for its effects other than in the usual coefficient of safety.

2. Bouncing invariably means that all the energy of the blow cannot be utilized in work, either because the pile has struck a solid obstacle to further penetration, which is soon detected, or because the hammer is too light or its striking velocity too great, or both, to get the pile in motion before it reacts elastically with more force than the hammer is exerting to push it down. In many cases the remedy indicated is a heavier hammer. In all cases the height of the bounce, and considerably more, represents so much absolutely wasted energy, which goes to increase the brooming but not to increase the penetrating force, because the energy escapes again from the pile before the latter begins to move. The judicious pile-driver, therefore, will and does cut down the fall at once, when he finds that bouncing occurs to any extent, and usually accomplishes far more with the lighter fall by so doing. A slight bounce at the end of every blow, as we shall see, is an invariable and necessary accompaniment of all good pile-driving.

3. Elastic compression within the limits of elasticity is not a source of loss except to a trifling extent, determinable as follows: it is necessarily greatest at the instant after impact. As the pile gets under way, the elastic compression necessary to transmit from the hammer through the pile a pressure sufficient to cause the pile to penetrate diminishes, but so long as the hammer and the pile together are moving downward this decrease and resulting elastic expansion all takes effect to cause the foot of the pile to move a little faster than the head and the hammer above it. After the energy of the blow is so spent that the pile can penetrate no further, the remnant of elastic compression in the pile can only expend itself upward, and it then causes a slight bounce of the hammer. Except that the speed of expansion is not quite quick enough it would, we may well believe, cause a considerable bounce, as it does in any case at times.

This last remnant of energy is wasted, but it also is small and negligible, except in enforcing the necessity of a coefficient of safety. None of the formulas which nominally take into account the elasticity of hammer and pile really allow for it in this way. Therefore, except for the proviso hereinbefore considered, all that we need to take into account in seeking to determine some measure of the bearing power of piles, is the work done in actually moving the pile. (Items 4 and 5 above.) This I have dealt with as follows:

Let the ordinate os (Fig. 1) = the penetration of any given pile under a blow, and let the rectangle os CB = wh = the energy in foot-pounds of that blow. Then will the abscissa sC = the mean resistance of the pile during its set. In what manner is that resistance actually distributed, and what part of it bears the nearest relation to the future bearing power of the pile?

So far as the inertia of the pile is concerned, that does not enter into the problem, except as affecting the elastic compression of the pile, which we have already considered. The energy absorbed in acquiring velocity

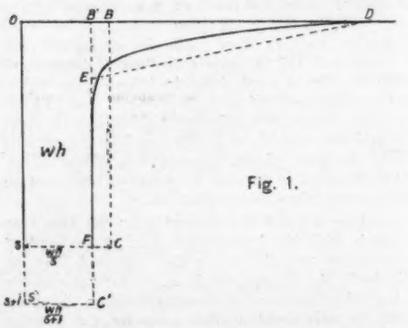


Fig. 1.

is given out again in surrendering it, and the mean result is the same. What we are after only is the external resistance to the motion of the pile.

In its absolute amount, this is as variable as the earth itself. But reasoning from the general laws of friction and the known nature of earth, these general conditions must obtain: at the instant after impact there must be a very large excess of external resistance, oD (Fig. 1), due to two permanent causes: (1) the excess in the coefficient of static friction or of friction at very low velocities over that at relatively high velocities, and (2), the settling of the earth around and into the irregularities of the pile, in the interval since the last blow. This last, in fact, may be considered as a general phenomenon, which occurs, in some degree, with all surfaces in frictional contact, so that (2) is only a part of (1).

Under the general laws of friction between such substances, as I understand them, this heavy excess of initial friction, oD (Fig. 1), will rapidly, but not instantaneously, decrease to some point E, where it will have a much reduced value, s'c', which thereafter will remain sensibly constant during the remainder of the set. In this case, we have the irregular figure of oDEFs, whose area must = wh.

The nearest measure of the future bearing power of the pile, obviously, will be the comparatively uniform frictional resistance to penetration, sF (Fig. 1), after the initial excessive resistance has been overcome; because, in large part, this excess is due to the suddenness with which the blow acts on the pile, and a gentler unceasing pressure of much less force in pounds may overcome it; besides which, tremors, seepage of water, yielding of surrounding soil, and other like causes may overcome it. The same causes may partially overcome the smaller constant resistance sF, but that possibility we allow for in the coefficient of safety. All that is claimed is, that this force, sF, comes the nearest to a true measure of future bearing power of all possible constants.

To determine sF in terms of non-variables, we must construct a rectangle os'C'B' whose area = oDEFs = osFB' + DB'E = wh, which I do as follows:

I assume that the decreasing excess resistance outlined by the line ED, and whose value in foot-pounds is expressed by the irregular area B'ED, is confined

within the first inch of penetration (i. e., that B'E = 1), and that the initial excess B'D = 3oB' = 3sF. The selection of these particular constants instead of others a little higher or lower is pure assumption, in the sense that we can never know experimentally, or, at least, do not now know just how this is. But it is based on extensive observations of the behavior of piles in driving and on many years' experiment and study as to the general laws of friction, as embodied in part in my paper on that subject (Transactions Am. Soc. C. E., 1884, Vol. XVIII, p. 409), where the diagram of actual observations on page 420 will be found to bear a striking resemblance to Fig. 1 of this discussion. I have no doubt that the above assumptions are essentially accurate and suitable, especially as considerable modifications thereof do not essentially modify results. That the general nature of the distribution of force is correctly outlined in Fig. 1, does not in my judgment admit of doubt.

Under these two assumptions we have geometrically,

$$\text{Triangle } B'FD = \tfrac{1}{2}\, B'D \times B'E = \tfrac{1}{2}\,(oB' \times 3) \times 1 = 1\tfrac{1}{2}\, oB'.$$

But, furthermore, the irregular area B'ED is geometrically equal to about two-thirds of triangle B'FD, whence

$$\text{Irregular area } B'ED = oB' \times 1.$$

Then, in order to determine the value of the abscissa oB' = sF = s'c', we must add to the rectangle oF an area = oB' × 1, which we do by making ss' = 1 and s'c' = oB', whence we have, letting oB' = R = the assumed maximum bearing power of the pile—

$$wh = R \times (s + 1);$$

whence we have

$$R = \frac{wh}{s+1};$$

or, if h be in feet and s in inches, as usual,

$$R = \frac{12wh}{s+1}.$$

This was and is my formula for the probable ultimate bearing power of piles. Barring the petty exceptions noted above, I believe it to be incapable of further refinement and amplification in any way in order to express more accurately the probable ultimate bearing power; and I believe it to be especially unwarranted and injurious to tamper with the constant 1, as Mr. Crowell proposes, in order to allow for future conditions of the pile, in respect to tremors, or in respect to the importance of stability. That constant has no relation to such allowances, any more than the variables w, s or h. The proper way to allow for these future differences of conditions, and the only proper way, is by varying the coefficient of safety.

For myself, I assumed the factor 6 as the coefficient of safety, giving to the formula the form

$$S = \frac{2wh}{s+1}$$

in which S = the safe load in the pile = 1-6 the probable ultimate. I assume 6 as a factor of safety, rather than 4 or 5, simply because I found 6 to give as big loads as are customary, or as are in many cases safe. I do not question that in many cases a factor of 2, 3, 4 or 5, or even 1, might also prove safe. In some cases they have done so, but in other cases they have not; whereas I have as yet discovered no cases where the factor 6 had proved insufficient, either experimentally or in service. As the factor 6, moreover, will in no case require piles to be driven closer together than is customary and reasonable, I should advise in all cases adhering to it, unless under some very exceptional circumstances, where the engineer may see that he has special cause and justification for taking more chances. He can be reasonably sure that his pile will do its allotted work safely with a factor of 6, but not with a smaller factor—that is all.

Apart altogether from the special reasons so far advanced, it is wrong in principle to tamper with the constant 1 and make it a variable, in order to vary the factor of safety to suit future conditions, as Mr. Crowell proposes. That constant is a part of the denominator of a fraction. For well-understood mathematical reasons, if it is desired to increase the value of a fraction by 10, 20, 50, 100 or any other per cent., which is what Mr. Crowell is aiming at, it is impossible to do so in any simple way, by modifying the denominator. It should be done by a factor modifying the fraction as a whole, i. e., multiplying the numerator. When, as in this case, the denominator consists of two terms, any attempt to vary the value of the fraction to suit any desired coefficient of safety, by varying only one of the terms of the denominator, is particularly objectionable.

A further reason why the constant 1 should not be tampered with, is that, as it happens, in the extreme case when s = 0, i. e., when the pile has struck solid ground and can penetrate no further, the formulas reduce to the form R = 12wh, and S = 2wh, which happen to be just about what the pile can safely carry as a column, as ultimate or safe loads, under ordinary and probable values of w and h, whether regarded as a short column with its bearing power limited only by the crushing strength of the wood, or as a long column liable to flexure. Therefore, it becomes unnecessary to consider the special case of the pile acting as a column. The formula is general for all conditions. When the constant 1 is reduced to considerably less than 1, as Mr. Crowell proposes, the apparent safe loads become excessive, and considerably more than the crushing strength of the pile itself. As it is only in these cases that Mr. Crowell's proposed modifications give materially different loads from the original simple form of the formula, it will be seen that the added complexity is not only without advantage, but distinctly injurious.

To prove this fact I have computed the following table, which sufficiently explains itself. The last three columns give the ratio of the safe load, indicated by three cases of Mr. Crowell's modified formula in comparison with my original simple form. The table may be divided horizontally into two main parts, that for penetration of less than 1 inch and of over 1 inch.

Considering the small penetrations first: Mr. Crowell's modifications have substantially no effect on piles for machinery foundations, nor on any piles where the penetration is as much as one-half inch. Less penetrations than that are generally bogus, as practical men know, and indicate that the pile is brooming and mashing rather than penetrating further. For these cases Mr. Crowell's modifications indicate that from one and one-half to three times greater loads are safe, but this is untrue as a fact, as just stated, for the simple reason that such loads amount to one-half to three times the safe strength of the pile as a column.

For penetrations above 1 in., Mr. Crowell's formula gives almost identical results for "ordinary cases" in a much less simple way; but for railway bridges he says, in effect, that my simpler form gives 2 to 8 per cent. too great loads, and for machinery foundations he says, in effect, that my form gives 10 to 12% too great loads. These are small differences to dispute over; but I deny the fact that they exist, or that there is any evidence to show that they exist, or tending to show it. Certainly Mr. Crowell advances no evidence to show that they do. I think he will be surprised to find how little effect upon the final result his apparently considerable modifications of the original simple formula really have. Before proposing them, evidence should be advanced to show that the simpler formula is really the less trustworthy of the two in some one case, at least; and, assuming that evidence to have been produced, the proper way to give it effect is to make the coefficient 2 of the numerator a variable and not the constant 1 of the denominator.

I must not be understood to take the position that the load placed on piles should not be decreased in important structures subject to tremor, or that it may not be increased for carrying unimportant temporary structures. I merely say that any excess or deficit in such cases is guesswork, pure and simple, and therefore does not belong in a formula. The way to make such changes is to space the piles a little nearer together or farther apart than we otherwise would; not to "monkey with" our basic formula (which is already as exact as theory permits us to make it) by arbitrary changes in the general direction of the allowances we wish to make.

Relative Safe Load Indicated by Original Engineering News Formula, and the Same as Modified by Mr. Crowell.

Set S.	Engineering News.	Ordinary cases.	Railway bridges.	Machin'y foundations.
None.....	1.00	3.08	1.37	1.15
0½.....	1.00	2.08	1.56	1.13
0¾.....	1.00	1.58	1.30	.97
0⅞.....	1.00	1.37	1.18	.93
1.....	1.00	1.25	1.11	.91
2.....	1.00	1.07	.98	.88
3.....	1.00	1.08	.96	.88
4.....	1.00	.98	.94	.88
5.....	1.00	.97	.93	.88
6.....	1.00	.95	.93	.88
7.....	1.00	.95	.93	.89
8.....	1.00	.95	.93	.89
9.....	1.00	.94	.93	.89
10.....	1.00	.94	.92	.90
11.....x	1.00	.94	.92	.90
12.....	1.00	.94	.92	.90

(To be continued.)

A STANDARD RAIL HEAD FOR STREET RAILWAYS.

A paper on the above topic was presented at the Cleveland meeting of the American Street Railway Association by Mr. John F. Ostrom, of the Pennsylvania Steel Co. After extensive correspondence with street railways, and manufacturers of wheels and rails, he found that the wheel which at present meets the needs of all classes of street railways most nearly has a 2¼-in. tread and a flange ¾-in. deep. The rail designed to carry such a tread: "should have a head flat, or nearly so, 2 5-16 ins. wide, with a curve not over ¼-in. on the gage line corner, and a dip of 1 in. to the wagon flange in side bearing rails, and 1⅛ in. to bottom of groove in groove rails. The width of head and the gage line curve can be made alike in both T and girder rails. Distance from center line of web to gage line in girder rail 5-16 in. My reason for making the groove deeper than dip in side bearing rail is that in the latter both head and flange are subject to wear, while in the groove rail the wear is confined to the head of the rail until the wheel flange strikes the bottom of the groove."

The following is an abstract of the paper:

I have seen rails weighing from 30 to 98 lbs. per yd., and varying in height from 3 ins. to 9 ins., used for the same kind of traction without, so far as I could see, any effort being made to standardize either weight or shape. On the same road I have seen eight different sections of girder rail in use, besides a stringer rail and four different sections of guard rail.

My first statistics were collected from car builders and car wheel and car truck manufacturers. Twenty-one replies were received, of which eleven reported that most of their wheels were made 2¼-in. treads and ¾-in. flange, and six stated that 2-in. tread was specified in the majority of their orders. The following is the letter of a prominent truck manufacturer:

The street railways generally in the large cities are using a wheel having a 2-in. tread and a flange not exceeding ¾ in. This width of tread I regard as altogether too narrow for electric purposes; and consider that it is used by the railway companies in deference to the fact that their horse car rails are not adapted usually to a wider tread. If you will permit a suggestion, the tendency of electric railroading, as you are doubtless aware, is to higher speeds than heretofore; and, also, there is a decided tendency to connect towns miles apart by the electric railway. This means, I think, that in the near future long distances will be traveled, largely in the country, and very high speeds will be attained. Consequently, the tendency will be to use broader treads and deeper flanges. I should recommend that your standard rails should be adapted to a wheel having a minimum tread of from 2¾ to 2⅞ ins. for city use, and an allowance should be made by which at least a ⅞-in. flange might be used on the rails. We should prefer to put out a wheel having a tread full 2⅞ ins. in width, and we put out 2 ins. only because the 2¼ ins. are not suitable in all cases for the old rails which are sometimes used.

Following this, letters were sent to every street railway company in the United States and Canada asking for particulars as to the kind of road operated, width of tread and depth of flange used, kind of paving in use or in contemplation, legislative or corporation enactment governing type of rail to be used, and suggestions as to what would constitute a rail that could be used by the majority of the street railroads.

The replies showed that wheel treads varied from 1½ ins. to 5 ins.; flanges, from 7-16 to 1½ ins.; rail sections, from 16-lb. T to 98-lb. girder. One city council unanimously requested the road take up all girder rail and lay T rail instead. Another specified both form of rail and weight (groove girder, 77 lbs.), while others specify a rail of a particular manufacturer, or a rail with a stated width of wagon tread.

Suggestions as to standard varied as much as conditions. On one point only all seemed to agree and Ohio voiced the general sentiment: "Tram rails no account for anything or anywhere."

One road wrote, "There should no rail but a T rail be used where the city authorities will allow it." Another: "Plain T every time, under all circumstances of paving or traffic." Another: "There seems to be a popular prejudice against T rail for street work which is exercised wholly without reason; and, so far as the T rail for the very best service goes, there is no chance for argument."

Against these were suggestions for side-bearing rail, with various widths of wagon flange, and for center-bearing and groove girder rails; 88 companies, operating 1,083 miles of track, suggested T rail; 60 companies, operating 1,101 miles of track, suggested girder rail; 45 companies, operating 1,243 miles of track, suggested a section of girder rail deep enough to be spiked direct to tie in paved streets.

There are now on the market, besides the various sections of T rail, over 90 sections of girder rail, with 15 different widths of head varying between 1⅛ ins. and 2½ ins. These rails have 10 variations in flange room or dip, from ⅜ in. to 1 3-16 ins.

The adoption of one width for rail head and one depth for flange room would, in my judgment, be the nearest approach that can be made to a standard rail. With these measurements, specifications should be given as to the distance of gage line from center of web of rail and radius of curve at gage line. With these points decided, it would be comparatively easy for the railway companies to settle the question of a standard wheel tread and flange. Rails bought from one manufacturer would connect at gage lines with those of another. Rails could be carried in stock by the various manufacturers, and many of the expensive delays incident to new construction during the past few years could be thereby avoided.

The necessity for a standard recognized, is it possible to devise one that can be generally accepted as such? In response to inquiries already referred to, I received

replies from 306 roads, operating cars on 4,347 miles of track, divided as follows:

	Roads.	Miles.
Steam motors	20	155
Cable	29	628
Horses	99	1,117
Electricity	198	2,748
Total	346	4,348

Of these same roads 59 have 625 miles of stringer rail; 197 have 1,552 miles of T rail; 146 have 2,190 miles of girder rail.

Two hundred and sixty-four roads, operating 3,937 miles, also reported the width of wheel tread.

170 roads, operating 2,942 miles, use 2¼ ins. or less tread.
56 " " 568 " " 2⅛ " " "

If these could be combined, and a 2¼-in. tread wheel substituted, we would have 226 roads, operating 3,510 miles, or about 84% of the total mileage reporting, using a common wheel tread.

Two hundred and seventy-nine roads, operating 4,118 miles, reported depth of wheel flanges, varying between 7-16 in. and 1⅛ in.

223 roads, operating 3,581 miles, use ¾ in. or less flange.
26 " " 298 " " ⅞ " " "

If these could be combined, and a ¾-in. wheel flange adopted, we would have 249 roads using this wheel flange on 3,879 miles of track, or 94% of the reported trackage. The adoption of such a wheel flange will be perfectly safe wherever the radius of curve at gage line of rail is not over ¼ in.

Taking now the statistics for electric railways alone, of which 2,748 miles was reported, and arranging figures like those above, we have:

109 roads, operating 1,870 miles, use 2¼ ins. or less tread.
51 " " 512 " " 2⅛ " " "
146 " " 2,244 " " ¾ " " flange.
24 " " 256 " " ⅞ " " "

If these roads would unite on a 2¼-in. tread and ¾-in. flange, we would have using the standard tread 160 roads, operating 2,382 miles, or 90% of total reporting, and 170 roads, operating 2,500 miles, or 95% of the total, would use the standard flange. The proposed standard rail head was then described as above.

COAL TIPPLE AT DUNLOW, W. VA.

By Emile Low, M. Am. Soc. C. E.

The mines of the Dunlow Coal Co. are located at Dunlow, W. Va., on the line of the Ohio extension of the Norfolk & Western R. R. Dunlow is on the west fork of Twelve Pole River, and is 46 miles from Kenova, W. Va., at which latter point the Norfolk & Western R. R. crosses the Ohio River. The tipple, of which we give drawings and a photograph, is located on a siding which parallels the main line of the railway. It has switch connections at both ends and is 1,790.4 ft. in length. At the eastern end there is a short level, followed by an ascending grade of 3.25%, 290.47 ft. long, to a knuckle, the grade then descends at the rate of 2% for 959.53 ft., after which there is a short level to the western connection with the railway. The tipple is about midway on the descending grade, at which point the loading siding is 10 ft. above the main line. The grades are rather steeper than advisable, but the configuration of the ground precluded the use of lighter ones.

The method of operating the siding is as follows: The train of empty cars running from the west is stopped at the eastern end of the siding, and the cars are then pushed up the 3.25% grade, over and beyond the knuckle, the first car being stopped at the tipple. After loading, the car is dropped still further down the 2% grade, and another car is put in place, and dropped down as before after loading. This operation is repeated until the cars are all loaded, when other empty cars are run in. The capacity of the siding is about twelve cars.

The floor of the tipple is about 60 ft. above the top of the rails of the siding, or 70 ft. above the track of the main line. The coal is brought to the tipple by means of a tramway, which leads from the mouths of the various entries. This tramway has a descending grade of about 2%. It is operated by mule power. The tipple is so arranged as to have two storage bins, one on either side of a central lump coal chute. The capacity of each bin is a little over that of a large car load. The bins are 8 ft. 8 ins. wide inside, and about 42 ft. long, measured on the slope. The floors have an inclination of 30°, while that of the lump chute is 40°. The bottoms of both bins and chute are covered with ⅛-in. sheet iron. The larger number of timbers are 10×12 ins. in size, especially the posts or uprights. These latter are tied together by 6×12 in. stringpieces, both the posts and stringpieces being dapped or boxed out 2 ins. The stringpieces are fastened to the posts by ¾-in. bolts. The stringpieces furnish the rests for the floor joists of the bins and chute. The joists are also 6×12 ins. in size. There are four supporting the bottom of each bin, and two for the lump chute. The floors of each consist of 3 in. plank, the first layer being placed at right angles to the joists and the top layer parallel with the same. These planks are securely fastened by means of 8 in. boat spikes. The sides of the bins and chute are also covered with 3-in. plank, securely spiked on. The joists are also secured to the posts by ¾-in. bolts. The sills and caps are made of 12×12 in. timbers. The floor stringers on the top of the structure are also of the same dimensions, and are in turn covered with 3-in. plank.

COAL TIPPLE AT DUNLOW, W. VA.

On top of this is a suitable house in which the coal dump, scale box, etc., are located. It is well lighted by six windows and affords sufficient protection from the weather. Its construction is clearly shown in the photograph. The whole structure is securely braced both transversely and longitudinally.

The coal after being dumped from the pit wagons is passed over a 2-in. screen, the larger lumps passing into the weigh basket. Below the lump screen are two others, the nut and pea coal screens, the former having 1¼-in. and the latter ¾-in. apertures. Suitable inclines are provided at the bottom and ends of the nut and pea screens, conveying the coal to their respective bins. The slack coal is run into a suitable box, which is emptied from time to time into a mine wagon and hauled away. After the screened coal is weighed the weigh basket is lowered and the coal dropped into the lump chute, passing thence down to the railway cars.

The weigh basket is of the kind known as the end dump.

Suitable gates made of wrought iron are placed at the lower ends of the bins and chute. These gates are raised and lowered by ordinary levers, the arrangement of which is clearly shown by the drawings. Wrought iron chutes are also attached to the bins and chute, the inclination of which can be regulated by winches to suit the varying heights of cars.

An inspection of the drawings will show an auxiliary central chute, under the top one.

The lower chute is intended to be used when loading coal into box cars. When this is done a trap door which is located in the upper chute is opened, the coal dropping from one to the other. The counterweights which balance the weigh basket weigh about 1,400 lbs. The descent of the weigh basket is further regulated by a suitable brake apparatus. The weigh scales used are the Victor pattern, the capacity being 5 tons. They are made at Moline, Ill.

The tipple was erected by the Dunlow Coal Co. by day labor, the work being done under the immediate direction of Mr. W. J. Duryea, assisted by his brother, Mr. Andrew Duryea. The iron work, such as the screens, weigh baskets, chutes, doors, etc., was furnished by the Mineral Ridge Mfg. Co., of Mineral Ridge, O. The timber used in the construction of the tipple is white oak. The total cost of the tipple ready for work was about $2,500.

THE ENGINEERING SCHOOLS OF THE UNITED STATES.

XXX.

Courses in Mining Engineering.

We have received from Prof. Henry S. Munroe, of the Columbia College School of Mines, the following communication taking exception to some of the statements of fact and of opinion which we have made in these articles in reference to courses and schools of mining engineering. As the space required for the article and our reply together is considerable, and as the questions raised are of extreme importance to the present and future of many engineering schools, we give nothing else relating to engineering schools in this issue.

Sir: In your issue of Oct. 6, the author of the interesting series of articles on "The Engineering Schools of the United States" criticises unfavorably the average course in Mining Engineering of our technical schools. He calls attention especially to the large amount of time devoted to natural sciences, chemistry, geology, etc., and enlarges on the small portion of the student's time devoted to engineering. There is perhaps some ground for his criticism, and doubtless the course might be improved in many respects; but it is going too far to say that the mining course is "most ill-judged" . . . "from which no possible student can gain any advantage."* The apparent lack of balance and logical purpose in the mining course is due mainly to your author's classification of studies and their arrangement in his diagram, which fails to bring out the salient features of the mining engineer's education. For example, Metallurgy, one of the most important subjects in the whole course, and one which occupies, directly or indirectly, a very large share of

* This quotation, like most other abbreviated quotations, does not represent quite fairly what we did say. We may as well append the latter in full, from our issue of Oct. 6, 1892, as the whole of this communication is a comment upon it.

"One puzzling question, at least, seems to be answered clearly enough in the accompanying diagram, viz., why the mining courses are so rapidly falling into inocuous desuetude. The average mining course as shown on the diagram would seem to be a most ill-judged course, from which no possible student can gain any advantage, unless he proposes to become a kind of scientific prospector. What are the duties of the mining engineer? One would suppose from the average distribution of time that the college conception of him was as of a man who goes roaming about the earth for strange geological formations, hunting for new rocks to analyze, assay or blow-pipe, from which he may get a good "show" for a new mine. The imagined being does not exist; at least not in numbers sufficient to warrant schools for training him, as he is at a great disadvantage with the rustler for grubstakes when he does exist. On the contrary, your typical mining engineer is a boundrum sort of fellow who takes a mine as it exists and contents himself with managing and extending its machinery, plant, reducing works (if any), drifts and shafting, and accurately surveying and mapping it, with some occasional simple

the student's time does not appear in the diagram at all! It is apparently included under geology! This classification not only gives undue prominence to natural science, but fails to show the object of other studies grouped under that general head. It is because our students have to be educated as metallurgists as well as mining engineers that so much time has to be given to analytical chemistry and to assaying. No doubt we could make better engineers of our graduates, if it were desirable or necessary to do so, if we did not have to teach them so much metallurgy, and we could certainly make them better chemists and metallurgists, if we did not have to devote so much time to mining and to engineering.

A step has been made in this direction in several of the schools by establishing parallel courses in mining and in metallurgy, emphasizing one or the other subject, but still giving both subjects in each course. It is doubtful whether even this partial differentiation into two courses is advisable at present. Most of the prominent mining engineers of the country are metallurgists as well, and necessarily so. The profession of mining engineer is of recent development with us, and the profession is not so crowded as to make specialists necessary, nor are mining engineers as yet sufficiently prominent and indispensable members of society to make the practice of a specialty profitable. The greater part of our graduates find employment in the West, and in South and Central America, where it is imperative that they should be equally well fitted in both metallurgy and mining.

From the standpoint of the civil engineer or that of the mechanical engineer there is doubtless too little time given to engineering in the course. There is, however, a radical difference between mining engineering, and civil and mechanical engineering, which should be recognized. Civil engineering is based on the arts of construction. The civil engineer is called upon to design and erect permanent structures. He must study critically the forces tending to destroy his work, and the strength and disposition of the material he uses to withstand these forces. The mechanical engineer designs and constructs moving machinery. He requires also a most intimate and exact knowledge of the forces he seeks to control and utilize, and of the strength and durability of the materials by which he controls them.

Mining, so far from being a constructive art, is rather an art of demolition, of destruction. The art of mining consists in excavating a mass of useful mineral as completely as possible with economy and with safety to the men. The mining engineer has no occasion to calculate the forces tending to crush his supporting pillars or props, or to consider the strength of material of which they are composed. A very little study will show that the forces brought into play by undermining the earth's crust are practically irresistible. The art of mining then consists in controlling and delaying the fall of the overlying rock masses until the mineral has been secured.

Again, the work of mining at any one place, in any one deposit, is temporary and lasts only until the deposit is exhausted. The work of construction at a mine, civil engineering or mechanical engineering, such as it is, is then necessarily of a temporary character.

Again, even this construction is an incident in the life of the mine, and the plant once designed and erected, the services of the civil engineer or of the mechanical engineer are at an end.

We see then that there is some ground for the curtailment of the engineering courses; and the undue prominence, as it appears at first sight, of the natural sciences and of mining and metallurgy.

Again, referring to our critic's diagram, the engineering studies are so scattered that it does not appear without careful examination how very large a share of the student's time is in fact devoted to the engineering side of his education. The higher mathematics, although they have of course a great educational value, are chiefly useful as preparing the way for mechanics, thermodynamics, and other engineering branches, and have but limited applications in metallurgy and mining. So also with drawing and surveying; while these are necessary and indispensable, they belong rather to the engineering side of our students' education. Grouping the subjects on this basis, we find that engineering studies occupy 47%, while mining, metallurgy and allied studies take 42% of the student's time. From this point of view, the course seems much better balanced. We may go farther than this and say that from a pedagogic standpoint the mining course is by far the best balanced and broadest course of the three, covering thoroughly all the principal divisions of natural science and no less than three of the useful arts—mining, metallurgy and construction, and thus a much wider field than either the mechanical or the civil engineering course.

This fact is still further emphasized when we consider the occupation of the graduates of our mining schools. While the larger proportion find employment in mining or metallurgy, for which they are specially fitted by their education, we find them also filling positions as assayers, analytical and manufacturing chemists, geologists, mineralogists, civil, mechanical, electrical and sanitary engineers, and professors and instructors in all these branches. Those that stick to mining apparently have nothing to fear from competition with the civil or mechanical graduates, but more than hold their own. The following table gives the occupation, so far as known, of the mining graduates of the School of Mines, of Columbia College.

The above table was compiled about two years ago, and if brought up to date would make a still more favorable showing. Compared with a similar table made nearly ten years ago,* a decided gain is shown in many respects. By this it appears that 92.3% of the graduates are engaged in professional work as compared with 75% in 1883. Including the geologists who are at work in the mining regions or who are teaching in mining schools, 60% are doing the work for which they were trained in the school. In 1883 but 46% were so engaged.

It will be interesting to compare the above table

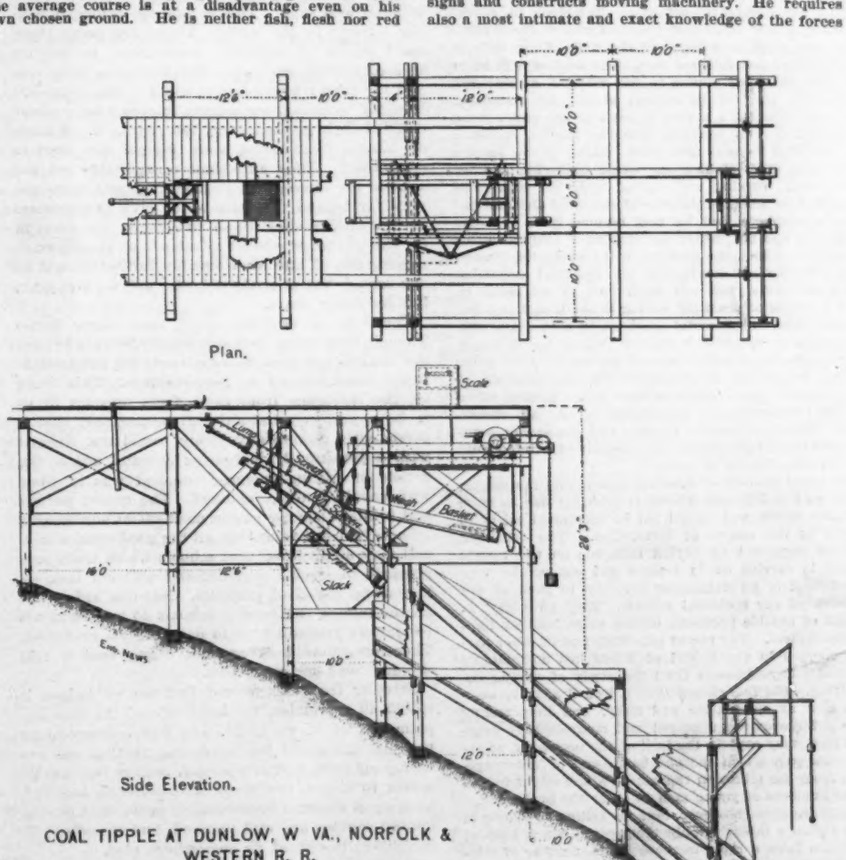
* School of Mines Quarterly, June, 1883.

chemical work. Except for general information he has no more need of profound geological knowledge than his workmen; all he knows which he uses practically he acquires just as his workmen acquire it, by practical experience with and observation of the particular formations that he is working in at the place where he is working. All the chemistry he uses (when he uses any) are a few routine processes, soon learned, for dealing with his particular ore. His special reason for being is that there are engineering duties connected with mining work for which some special training is necessary. But the kind of training needed for this is precisely that which the civil and mechanical engineer gets, not at all what the chemist gets.

"Therefore, the mining engineer who graduates from the average course is at a disadvantage even on his own chosen ground. He is neither fish, flesh nor red herring. He is not so good an engineer as those who graduate from other engineering courses, because he has not been so thoroughly grounded in engineering. He is not so good a chemist as those who graduate from a chemical course for the same reason. Other things being equal, the civil or mechanical graduate will beat him on his own ground, while he is not nearly so well qualified to compete with them on theirs.

"The qualities of mind which make the engineer are in some respects radically different from those which make the good chemist or geologist. The one is mainly practical and requires before all things a certain energy and executive faculty; the other is purely scientific and requires before all things, an almost infinite patience and love of minute observation. The two do not combine well in the same man; the man who combines them best will not be quite the best in either. Our mining companies are growing larger and larger and will have the best in both lines. The conception of combining the two in one man is a false one, and hence fewer and fewer take the course, which we fear has been modeled too closely on German models, where different social and industrial conditions obtain.

"So, at least, it appears to us. In this and all other matters we speak with some reservation and subject to correction. In this and all other questions connected with schools and colleges there is plenty of room for a legitimate difference of opinion. Especially in regard to the distribution of studies and comparisons of one college with another, so much depends on the character of the instructors themselves that it is all but impossible to make any fair comparison."



COAL TIPPLE AT DUNLOW, W. VA., NORFOLK & WESTERN R. R.

with a similar one compiled on the same basis for graduates of civil engineering. The civil engineering course in the School of Mines is of comparatively recent development and therefore not available. I have for this reason compiled the following from the graduate list of another institution (the Massachusetts Institute of Technology) of about the same age as the School of Mines.

Present Employment of Graduate Mining Engineers from the Columbia College School of Mines.

	No.	P. C.
Mining:		
Mine surveyors	13	
Draftsmen and designers	12	
Assistant superintendents	18	
Agents and business managers	8	
Superintendents	40	
Professors and instructors	9	
	100	29.5
Metallurgy:		
Assayers and chemists	9	
Assistant superintendents	7	
Superintendents	29	
Professors and instructors	3	
	48	14.1
Mining and Metallurgy:		
Consulting engineers	51	15.0
Geology and Mineralogy:		
Geologists	4	
Professors and instructors	2	1.8
Grand total, mining, etc.	205	60.4
Civil and mechanical engineering:		
Assistant engineers	25	
Chief Engineers	6	
Consulting Engineers	6	
Professors and instructors	8	
	45	13.3
Chemistry:		
Manufacturing chemists	9	
Analytical chemists	11	
Professors and instructors	7	
	27	8.0
Professional and manufacturing	36	10.6
Agriculture and Commerce	26	7.7
Total of known occupations	339	100.0
Occupation not known	22	
Students	4	
Dead	23	
Total graduates E. M. and Met. E.	388	

Employment of Graduates of Civil Engineering.

Civil Engineering:	P. C.	P. C.
Surveyors, draftsmen and assistant engineers	46.5	
Chief engineers and superintendents	12.5	
Consulting engineers	14.5	
Professors and instructors	8.5	82.0
Mining Engineering	3.5	
Professional and Manufacturing	5.0	8.5
Agriculture and Business	9.5	9.5
	100.0	100.0

An examination of the records of the mechanical engineering graduates from the same institution shows that a much smaller number go into mining—less than one per cent. of the total number.

Several things are evident from a comparison of the above tables: 1. But a very small proportion of the graduates in civil engineering find employment in mining. 2. The field of employment for the civil engineer is much narrower than that for the mining graduate; and, finally, 3. The promotion of the mining graduate when he follows his own profession is much more rapid than that of the young civil engineer. It does not appear that "the mining engineer is at a disadvantage on his own chosen ground" as stated, or that "the civil or mechanical graduate will beat him on his own ground" as claimed by your critic.

The aim of the young graduate in mining should be for positions as assistant superintendents of mines. A few mine surveyors will make all the surface and underground surveys for a large mining district. Again, as already shown, the work of construction is but an incident in the life of a mine, so but few draftsmen and designers are required, and these chiefly by makers of mine machinery. As mine surveyors and as designers and draftsmen the mining graduate comes into competition with civil and mechanical engineers, and with surveyors and mechanics of little or no scientific education. The demand is not large and the supply is unlimited. As mine surveyors or as draftsmen the graduate will have small chance of promotion, as these men have but little to do wtih the mine management. The principal field for the services of mining graduates is, and will be for many years, as superintendents and assistant superintendents of mines. This is now the principal mining country of the world. There are here many thousand mines of sufficient importance to require trained superintendence. The field is a large one and the supply by no means equals the demand. A large proportion of our mines are managed by incompetent men, with neither scientific nor practical training, and the waste of capital resulting from their ignorance is enormous. The mining graduate has to compete for the position of mine superintendent chiefly with the practical miner who has worked his way up from the ranks. And a very formidable competitor he is. Besides being thoroughly familiar with all the details of mine work, he has probably picked up a good deal of scientific knowledge and is familiar with the mineralogy and the geology of the mine and region. When, however, he meets with new problems in geology or in mining, or when he is transferred to some other mine, or mining region, where the conditions are different, he is "all abroad" and makes woeful mistakes. In his own mine and field he is all but impregnable; in new regions, the mining graduate competes on more equal terms.

The education of the mining engineer has to be adapted to these peculiar conditions. The graduate can obtain a foothold in the mine as a surveyor or as a draftsman, and in the smelting works as an assayer or a chemist. The course of instruction should make him an expert in these lines. The civil or mechanical graduate usually serves an apprenticeship under a skilled engineer, who can give him such training as he may need in field and office work. The mining graduate will have no such assistance, and must depend on himself. Once the mining graduate obtains a footing he must seek to make himself useful to the mine management, and work into the position of assistant mine boss, and so be in the line of promotion. For this he must be as familiar as possible with the practical details of mine work, sinking, drifting, stoping, timbering, etc. His education in this respect should begin in the school or he will make but slow progress afterward. For this purpose summer schools of practical mining are necessary—not mere excursions to mines, spending a few hours under ground and on the surface at a new mine each day, and the bulk of the time in hotel parlors and railroad cars. The student will learn but little practical mining in this way. A regular and systematic plan of instruction should be organized, the class spending a month or more at one mine, going underground each morning with the miners, spending the day with them at their work, taking up one subject at a time, shaft sinking one week, timbering another week, etc., working and eating with the men, and absorbing as much as possible of the mine dirt and the mine atmosphere that he may become quite at home in his new and unfamiliar surroundings. Started in this way in the school, the graduate will feel the importance and necessity of completing his practical education when he leaves, and will know how to set about it. Such a school of practical mining is not imaginary, but has now been in successful operation in connection with the School of Mines of Columbia College for 16 years, and our example is being followed gradually by the other mining schools of the country. The organization of this summer school seems to have had a marked effect on the occupations of our graduates. At all events, since its establishment, a large and increasing number have found employment as assistant superintendents and superintendents of mines.

The small number of students now taking the mining course at the different schools is probably due to more than one cause, and should not be attributed solely to defects in the course of instruction. The following may be suggested as having influence on the result: Mining is carried on in remote and out of the way places, and is an unfamiliar industry to most of the students of our technical schools. They naturally, in default of outside pressure, choose more familiar lines of employment. The recent establishment of other parallel courses in the School of Mines has undoubtedly diverted many students from the study of mining engineering. The fact that mining is looked upon by business men as speculative and risky, and that mining is to a large extent managed and controlled by practical men may explain the lack of the necessary pressure from parents on the one hand, and of encouragement from the mines on the other, which might induce larger numbers of young men to enter the profession.

There are signs, however, that the falling off shown in your author's tables is only temporary. Since 1890-'91 there has been a rapid increase in the number of mining students, in the School of Mines at least, and we are now where we were in 1886-'87. This large increase will of course not show itself in the graduating classes at once.

Columbia College has by no means abandoned the field of mining engineering in establishing other courses of instruction in its School of Mines. On the contrary, the mining department has recently been reorganized and strengthened; and many improvements in the course, made possible by the larger teaching force, go into effect this year and next.

In conclusion, I know of no professional career that offers equal opportunities and advantages. The profession of mining engineering is not likely to be overcrowded for many years to come. Our mining graduates have no difficulty in securing employment, indeed it is often impossible to find men for the positions offered. When the young engineer obtains a footing at a mine, his promotion is rapid. A much larger proportion of our mining graduates fill responsible positions and draw large salaries than is the case with those in other lines of engineering practice.

Henry S. Munroe, Professor of Mining,
School of Mines, Columbia College.
New York, October 21, 1892.

With much that our correspondent says we fully sympathize, and we are glad to hear him present fully the other side of the question. If it were a question now coming up for the first time, that is to say, if engineering schools were now being organized for the first time, and one could only appeal to his inner consciousness for reasons as to what might, could, would or should result from their establishment, we might regard his argument as unanswerable. We probably should do so, for we confess we are unable to see any good reason why there should not be an important field for mining engineering schools, or why they should not meet with as much success as mechanical or civil engineering schools.

But the question is not now coming up for the first time. We have a large body of accumulated experience to guide us, and there are three facts which have been determined by that experience which appear to us to lie at the foundation of this discussion, and which our correspondent's arguments do not seem to meet. These are:

1. There is and has been for the past 20 years at least a vast and rapidly expanding field for the employment of engineers in mining work. As Prof. Munroe well says: "This is now the principal mining country in the world. There are many thousand mines of sufficient importance to require trained superintendence. The field is a large one and the supply by no means equal to the demand." Roughly speaking, our mining interests have about doubled their product every ten years. 2. Schools of mining engineering were among the earliest established. They antedated considerably all the schools for mechanical engineering, and were not very far behind the schools for civil engineering. 3. Notwithstanding these two facts, the demand for the education offered at schools of mining engineering has of late been steadily falling off, not at one school, but at many schools; not for one year, but for many years.

There is no escaping from these three facts. Though they were, perhaps, hardly known before, the records gathered for these articles have established them beyond all peradventure. This being so, the inference from these facts appears to us to be a perfectly natural and proper one, that a persistently diminishing supply could not co-exist with a persistently increasing demand unless the article of mining engineer supplied was in some way unsuited to the demand. The recent sudden and brilliant success of the mechanical engineering schools (not one alone, but all the good ones) is new and very direct proof that schools which train men properly to meet a real demand will not lack an increasing crowd of students. Not one alone, but all the mining engineering schools do lack students (so far as graduates up to date are an evidence). Therefore, that they are not filling well a real demand was our conclusion.

Starting from this proved fact (as we judged it to be) as a premise, we have offered the best explanation of it we could, and our correspondent has not succeeded in convincing us that we are wrong, or even partially wrong, mainly because he seems to ignore the facts of experience and fall back upon abstract reasoning, to prove that (1) the mining courses are well planned, and therefore (2) the difficulties must lie somewhere else.

This does not seem to us sound reasoning, especially as the other possible difficulties vaguely suggested toward the end of the letter do not seem to us at all to meet the case. We are by no means disposed to be dogmatic on the subject, but we feel bound to add further that our correspondent's reasoning from the present employment of graduates of the Columbia College School of Mines seems of dubious soundness.

That the probable usefulness of the several courses is indicated by the number of students who choose them rather than by the dubious records of what becomes of them after they graduate seems to us clear. The nominal positions of "Chief Engineer" or "Superintendent" may imply very different salaries, emoluments and prospects in mining and in railway service. The mere name is nothing. The one certain fact is that every graduate from any course who finds himself doing well encourages others to follow him, and that the algebraic sum of these encouragements determines the proportion of engineering students who take the one

course or the other. But since our correspondent has appealed to the facts as to the records of graduates, and invites comparison with the Massachusetts Institute of Technology civil course, let us see how the comparison really stands, by his own figures:

	C. S. of M. Mining grades.	M. I. T. Civ. grades.
Out of the total number, or	100.0%	100.0%
Deduct the professional and manuf'g, agricultural and commercial	18.3	14.5
Leaving	81.7	85.5
Deduct the professors and instructors	8.6	8.5
Leaving	73.1	77.0
Deduct the grades in branches other than that they chose at college	10.9	3.5
Leaving	62.2	73.5
Deduct chemists and metallurgists	11.8	.....
Remainder still following their chosen branch of engineering	50.4%	73.5%

In other words, only about half the School of Mines graduates, against three-fourths of the M. I. T. graduates, afterward follow the branch of the profession of engineering for which they were trained. This comparison in itself seems to us to go far to tell the story why fewer men are choosing the mining courses, and more the civil and mechanical.

If it be objected that the "chemists and metallurgists" should be included with the rest of the mining engineers as "following their chosen branch of engineering," we take issue on that point. It is true, as our correspondent declares, that all mining graduates "have to be" educated as metallurgists as well as mining engineers, as the courses are now shaped; but as a markedly less number at all colleges are taking the course where they "have to be" thus educated, we are driven to the perhaps erroneous conclusion that that combination is not found to be a fortunate one for future success. If it is not that, what is it?

PLATE GIRDER DRAWBRIDGE OVER THE DISMAL SWAMP CANAL; NORFOLK & WESTERN R. R.
(With inset.)

We illustrate on our inset sheet and in the accompanying cuts the general details and complete strain diagrams of the 120-ft. plate girder swing bridge recently built to carry the double tracks of the Norfolk & Western R. R. over the Dismal Swamp Canal at a point about eight miles west of Norfolk, Va. The new structure replaces an old drawbridge built by Mr. Albert Fink in about 1855, which had of course become too light for modern traffic, and, as the engineer further informs us, is designed to afford passage to Thomas Moore's much lamented young lady from that "Lake of the Dismal Swamp,"

> "Where all night long, by a firefly lamp
> She paddles her white canoe."

and such other more material craft as may now use the canal.

As will be seen from the general plans and elevation on the inset the bridge consists of four continuous plate girders supported on a center bearing turntable, which divides it into two arms, 76 ft. 6 ins. long and 43 ft. 6 ins. long respectively. The two inner girders are each 120 ft. long and the two outside girders are each 119 ft. long, or 1 ft. shorter to allow for the curvature of the ends of the bridge. Each girder is made up of a web 82 ins. deep and ⅜ in. thick with double angle stiffeners, and top and bottom chords of 5 ins. by 3½ ins. × ⅜ in. angles, with five cover plates, each. At the end of the short arm provision is made for a counterweight of 130,000 lbs. of brick and concrete, to support the extra weight of the long arm. The total weight of the bridge, including track and counterweight, is 200 tons.

The shipment of these four girders 250 miles by rail over the tracks of the Norfolk & Western R. R. was probably the largest shipment of this kind ever made in this country. The four girders were loaded on 16 platform cars, four cars to each girder, and arrived at their destination without mishap. At Lynchburg the train passed through a tunnel on an 8° curve.

At the pivot pier the four girders are stiffened by two cross girders which rest at their centers upon the top plate of the center bearing and support the bridge in turning. The construction of the center bearing is plainly shown on the inset To prevent the bridge from tipping there are six wheels which run on a track near the circumference of the turntable.

The bridge is operated by two hand levers; one for operating the machinery releasing the ends of the draw and the other the turning machinery. Both levers are located near the pivot pier of the bridge, and the arrangement of the machinery which they operate is quite clearly shown in the general elevation and plan and the several sections given. A different device is used to unlock each end of the swing, both of which are actuated by a single horizontal shaft connecting by means of bevel wheels with the operating lever. At the end of the long arm this device consists of a pinion and spur wheel gearing with a sector keyed to a transverse shaft. The partial revolution of this shaft withdraws the wedges supporting the end of the bridge and permits it to deflect sufficiently to release the rails. The mechanism at the end of the short arm consists of a traveling nut which connects with a bell crank operating a transverse shaft carrying the rail lifters. The turning machinery consists simply of a vertical shaft and pinion operating a horizontal spur wheel, which gears with a fixed rack on the turntable. The bridge is operated easily by one man.

The substructure of the bridge consists of a pivot pier and two abutments. The pivot pier is a cast iron cylinder filled with Portland cement concrete, resting on a foundation of 52 piles and supporting a granite coping 14 ins. thick. The foundation piles were 65 ft. long driven 3 ft. apart c. to c. with a 3,000 lb. hammer. The abutments are of granite masonry on pile foundations. The construction and dimensions of both the pier and abutments are shown in the illustrations.

The diagrams of bending moments and chord sections shown herewith explain themselves and need no further description.

The bridge was designed by Mr. Chas. C. Wentworth, M. Am. Soc. C. E., Chief Engineer of the American Bridge & Iron Co., of Roanoke, Va., which was the contractor for the entire structure. We are indebted to Mr. Wentworth for the drawings from which our illustrations were prepared.

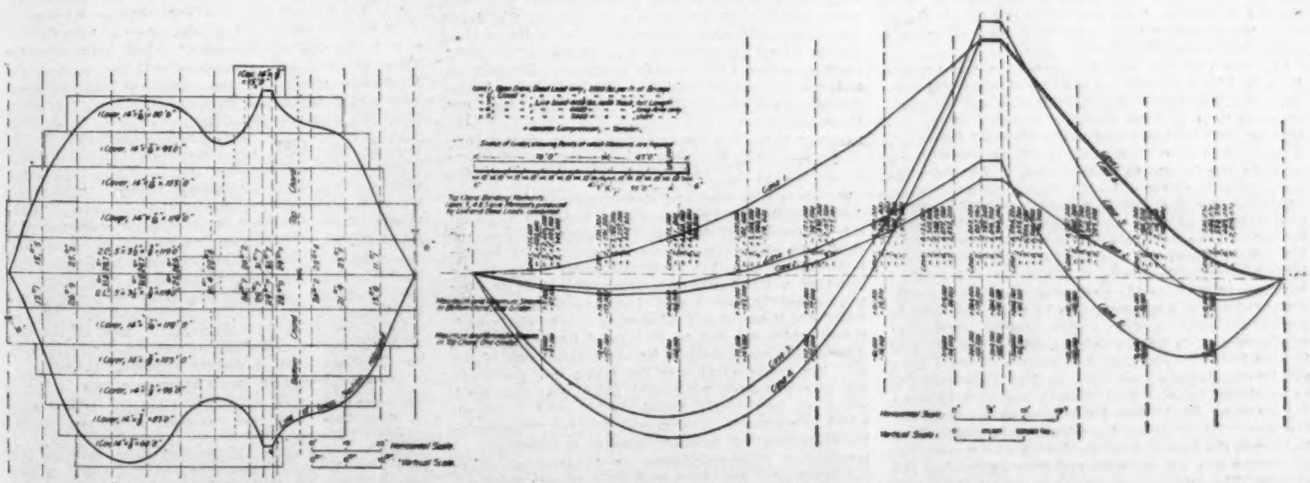


Diagram of Chord Sections. Diagram of Bending Moments.

PLATE GIRDER SWING BRIDGE OVER DISMAL SWAMP CANAL.

PERSONALS.

Mr. C. B. Bowen has been appointed General Manager of the New York & New England R. R.

Mr. Collingwood Schreiber, Chief Engineer of Government Railways, has been appointed Deputy Minister of Railways and Canals, of Canada.

Mr. J. W. Shanks has been appointed General Roadmaster of the Central Vermont R. R., with office at St. Albans, vice Mr. A. C. Bean, deceased.

Mr. James Ritchie, Principal Assistant Engineer of the Cleveland, Cincinnati, Chicago & St. Louis Ry., has resigned to engage in business in Cleveland, O.

Mr. William Campbell, a molder by trade, who died at Dallas, Pa., Oct. 22, helped to build the boiler for George Stephenson's locomotive "Rocket," in Liverpool, England, in 1829.

Mr. Meade Stilwell has been appointed Division Superintendent of the Eastern Division of the Missouri Pacific Ry., with headquarters at Sedalia, Mo., vice Mr. Alfred Marsh, resigned.

Mr. H. B. Hodges has been appointed Superintendent of Tests in the department of the General Superintendent of Motive Power, of the Baltimore & Ohio R. R., vice Mr. L. S. Randolph, resigned.

Mr. John Hardy, Division Superintendent of the Radford Division, Norfolk & Western R. R., died at Radford, Va., Oct. 22. He was a native of Pennsylvania, and had had experience on the Pennsylvania R. R.

Mr. W. J. McKee, formerly Superintendent of the Memphis Division of the Louisville, New Orleans & Texas Ry., has been appointed Superintendent of the Newport News & Mississippi Valley R. R. and Ohio Valley Ry., with headquarters at Paducah, Ky., vice Mr. W. E. Morse, resigned.

Mr. Karl L. Lehmann, civil engineer and architect, Portland Block, Chicago, Ill., has been appointed consulting engineer to the Fawcett Ventilated Fireproof Co., of Chicago, and is finishing the detail drawings for the spiral tower with movable sidewalk for the World's Fair Tower Co., at the World's Columbian Exposition.

Mr. A. Fteley, Chief Engineer of the New York Aqueduct Commission, delivered an exceedingly interesting and instructive lecture, entitled "Some Practical Remarks on the Construction of Dams," before the students of the Rensselaer Polytechnic Institute, Oct. 28. The lecture was made up principally of incidents and conclusions from his long experience as consulting engineer on dams, with remarks on limits of pressure and the effect of percolation.

Mr. Zenas King, President of the King Bridge Co., Cleveland, O., died Oct. 25. He was born in Kingston, Vt., in 1818, and went to Ohio in 1839. About 1850 he became an agent for the Mosley Bridge Co., and was a pioneer in iron bridge building. While connected with this company, he became impressed with the defects of wooden bridges, and designed the King type of iron bridge. In 1860 he obtained a patent for his invention. The King Iron Bridge & Mfg. Co. was organized in 1871. One of the most notable structures built by the company was the new bridge spanning the Ohio River between Cincinnati and Covington.

Mr. Charles S. Gowen, Division Engineer on the New Croton Aqueduct, has been relieved from the superintendence of dam and reservoir "M," on Titicus River, and put in charge of the construction of the new Croton dam at the Cornell site. The superintendence of the construction of dam and reservoir "M," has been put in charge of Mr. Alfred Craven, Division Engineer, the duties to be in addition to the duties now required of him as Division Engineer in charge of the Carmel dams. Mr. Edward Wegmann, Jr., Division Engineer, has been detailed to take charge of the work of the surveys and preparations required to be done in order to prepare for the construction of the Muscoot dam, and of the roads and bridges for the new reservoir on Croton River, under the direction of the Chief Engineer.

NEW PUBLICATIONS.

NOVEMBER MAGAZINES.—Harpers' this month has one of the most interesting World's Fair papers which has yet appeared. In it F. D. Millet tells of the "Designers of the Fair" and gives credit to whom credit is justly due for the group of great buildings which themselves will be one of the most striking features of the Columbian exposition. Fine portraits of the architects of the principal buildings accompany the paper. Julian Ralph writes on the "New Growth of St. Louis," giving a glowing account of that busy metropolis' prosperity and prospects.

In the "Popular Science Monthly" is an interesting account of the first German paper maker. Importing skilled workmen from Italy and keeping all his processes secret, he preserved for himself a monopoly; and from 1390 to 1407 the mill of Ulman Stromer was the only paper mill in Germany. The manufacturer's life even in those days was not without its trials, however. The workmen also had a monopoly, such a thing as a skilled paper-maker being unknown in Germany. Aware of the immense profits of their master, they tried to get him to turn the business over to them at a fixed rental. When he refused, they made him all the trouble in their power, turning out bad paper and little of it. The German's patience gave way and, according to his own account, he "seized the Italians and shut them up in a little room." At the end of the fourth day of their imprisonment they capitulated, and no further strikes are recorded in that paper mill.

In "The Forum," Joseph Chamberlain and Charles Francis Adams discuss the problem of Municipal Government. The former compares Boston and Birmingham and finds that the municipal expenses of the former are over six times as great as those of the latter, a disparity so great as to cause strong suspicion that it must be largely due to local causes, which make the comparison an unfair one. Mr. Chamberlain, however, concludes that the general cause of the difference is that in American cities the standard of work has fallen too low, and the standard of payment has risen too high. Mr. Adams praises the charter of Quincy, which places large powers in the hands of the Mayor and confines within narrow limits the powers of the City Councils, system of minority representation by which aldermen or councilmen may be chosen regardless of ward lines municipal politics by which members of the city legislative body shall be chosen regardless of ward lines and by cumulative voting. That is if 17 councilmen are to be elected, a voter may if he chooses cast 17 votes for one man. Prof. Edward S. Holden writes on "What We Really Know About Mars," and makes clear how little even the best telescopes aided by all the resources of science can tell us with certainty concerning the planets. The astronomers who have studied Mars with most diligence are divided on such questions as whether water, clouds or snow exist on Mars, and whether it is or is not in a heated state. Thus, so far from attempting to decide whether any of the planets are inhabited, astronomers are far from settling whether any of them are fit for habitation.

The "North American Review" has three papers on Cholera. Erastus Wiman pictures the enormous loss to the commercial world which would result if an epidemic should visit this country next summer. Dr. Jenkins tells the story of the stamping out of the disease at the New York Quarantine Station during September and October. Thos. P. Hughes, an English clergyman, who has spent a score of years in India, expresses the opinion that the cases in New York harbor were not genuine Asiatic cholera. Six months hence, he thinks, we may expect a visitation from the real pestilence; and his Indian experience leads him to expect better results from sanitation than from quarantine in fighting the disease. Lord Playfair has an interesting paper on "Waste Products Made Useful," written in a popular rather than a scientific manner, however.

"Scribner's" this month has a paper by Franklin MacVeagh on "Chicago's Part in the World's Fair." He describes well the remarkable enterprise which has accomplished feats that would have been impossible in any Eastern city; but protests too much in describing the source of Chicago's water supply as "ideal" and "good and wholesome and delicious almost beyond comparison." We have commented more fully in our editorial column on these misstatements.

In this month's "Century," Bishop Potter follows up his "Forum" article, noticed last month, with "Some Exposition Uses of Sunday." The publication of the letters which passed between Senator John Sherman and his brother, General W. T. Sherman, during the war, is begun in this number.

THE WOOD-WORKER'S MANUAL. A Treatise upon the Best Practical Methods of Constructing and Arranging Wood-working Plants, together with practical instructions for the care, management and preservation of the machinery.—By C. R. Tompkins, M. E. 8vo, paper, pp. 60. Illustrations.

While this pamphlet is published by the John A. White Co., of Dover, N. H., makers of wood-working tools, it is an excellent manual for the purposes outlined in its title, and has a corresponding value to those inter-

THE STANDARD ELECTRICAL DICTIONARY: A Popular Dictionary of Words and Terms Used in the Practice of Electric Engineering, by T. O'Conor Sloane, A. M., E. M., Ph. D., Author of "Arithmetic of Electricity," etc. New York: Norman W. Henly & Co. 12mo, cloth; pp. 624; 350 cuts. $3.00.

This appears to be a fairly complete electrical dictionary, somewhat smaller and sold at a lower price than Prof. Houston's work, reviewed in our issue of June 9. Like that, it is almost as much of a cyclopedia as a dictionary, explaining principles and devices as well as defining them. In place of the very numerous cross-references, which Prof. Houston employs, this author devotes the last 40 pages to an index, in which a copious use of cross-references has been made. For example, the dictionary defines "Discharger, Electric. In the index there are references to this page under the same head and also under "Electric Discharger."

INVENTIVE PROGRESS. Benefits of the American Patent System.—By Wm. P. Rosenbaum, Electrical Expert and Patent Solicitor. New York. Pamph., illustrated.

In this handsomely printed pamphlet the author gives a short sketch of American inventors and patents that is interesting and well calculated to awaken dormant talent in this direction. He shows that more than 475,000 patents have been granted since 1790, and that they are now issued at a rate exceeding 26,000 per year. The U. S. Patent Office now earns over $1,340,000 per annum and employs over 600 men in its service. Among classes of patents it is noted that car-coupling patents number 4,931; sewing machines, 3,570; knitting and weaving machines, 4,399; and agricultural implements of all kinds, 30,776, of which 7,271 are for plows alone.

SIMPLE LESSONS IN DRAWING FOR THE SHOP. By Orville H. Reynolds, Chief Draftsman Northern Pacific Ry. Terre Haute, Ind: Debs Pub. Co. 12mo, pp. 83, 100 cuts; $1.

This is a very neat and clearly written little work, dealing exclusively and concisely with the practical side of mechanical drawing, and apparently designed chiefly for shop apprentices or others without regular technical training, but containing many hints on the selection, use and care of instruments and on drafting work generally, which a good many college graduates might find it useful to read over as it is precisely such points which are apt to be passed by in silence in general text-books written by non-practitioners of the art. For the class of men for which this work was specially prepared, we should judge that this work might be particularly useful, as its very briefness, which in a sense is a defect, will save the young beginner from being too much discouraged in advance.

HIGHWAY CONSTRUCTION.—A Treatise on. Designed as a Text-Book and Work of Reference for All Who May be Engaged in the Location, Construction or Maintenance of Roads, Streets and Pavements.—By Austin T. Byrne, C. E. John Wiley & Sons, New York, 1892. 8vo, pp. 686. Many illustrations and tables. $5.00.

This is a seasonable and careful production, including the latest information on this important topic, well arranged and comprehensive. The subjects treated of, under general heads, are the characteristics of pavements; materials employed; stone, wood, asphalt, brick, broken-stone and miscellaneous pavements separately treated; foundations; resistance to traffic; location, width, etc., of country roads; earth-work, drainage, culverts, bridges, fencing, retaining walls, etc.; city streets, footways, curbs and gutters; the reconstruction and improvement of country roads; maintenance, repairs and cleaning of streets and roads; specifications and contracts, implements and prices. The author has carefully gone over a long list of authors and technical journals treating of these subjects and has abstracted and arranged under proper headings the widely scattered information thus made more available. His authorities are given in list-form and also in the important cases in the body of the text itself, so that the reader may refer to the originals for more minute information. The concluding chapter on tools and machinery employed illustrates the various machines in the market and gives the prices. It is a work that may well find a place in every engineer's library, whether he is especially interested in road construction or not.

RULES GOVERNING INTERLOCKING DEVICES, Adopted by the Railroad and Warehouse Commission of Illinois, Sept. 14, 1892. J. H. Paddock, Secretary, Springfield, Ill. 16 mo., pamph., pp. 21.

In 1887 the Illinois Legislature amended the law which required trains to come to a full stop before passing over the grade crossing of another railway, and permitted trains to pass without stopping over such crossings as were equipped with interlocking signals. It was provided that all such interlocking plants must be approved by the Railroad and Warehouse Commission. In 1891 a new law was enacted. The old law did well enough where two railways crossing each other were both progressive enough to unite in establishing interlocking plants; but in case one company refused to bear any part of the expense, or even to permit the establishment of the plant, the other road could do nothing, no matter what the urgency of the case. The new law places the protection of such crossings with the Railroad Commission. Either of its own motion or upon petition of one of the parties in interest, it may order a hearing to consider the establishment of an interlocking plant at any grade crossing. If at the close of the hearing the Commission shall conclude "that the public good requires that such crossing be protected," it may order the establishment of a plant, and apportion the cost. Another excellent provision of the law is that when one railway company seeks to cross the tracks of another at grade, and an interlocking plant is ordered, the company seeking to cross must pay the whole cost of the plant and its establishment, with all charges for its future maintenance.

The pamphlet just issued contains both the statutes referred to above, with the rules adopted by the Railroad and Warehouse Commission concerning the arrangement of the details of interlocking plant. Mr. Chas. Hansel is the Commission's Consulting Engineer. Copies may be obtained by application to the Secretary as above.

OHIO SOCIETY OF SURVEYORS AND CIVIL ENGINEERS.—transactions of the Thirteenth Annual Meeting, Held at Columbus, O., Jan. 19, 20 and 21, 1892. 8vo, pp. 184; illustrated. Price, 50 cts.; postage, 8 cts.

In addition to the minutes of proceedings, president's address, reports of committees, etc., the volume contains the following papers: "The County Surveyor," J. C. Grim; "Practical Experience in Land Partition," S. F. Rock; "Record of Surveys," D. W. Seitz; "Platting Town Lots," George McGormley; "Conveyancing," W. E. Peters; "Survey of the Boundary Lines Between Ohio and Indiana, and Ohio and Michigan," M. Graham; "Annual Change in the Declination of the Magnetic Needle; Is It a Constant Quantity?" E. W. Dimock; "Details in Ditch Location," A. D. Sheldon; County Ditch Assessments," H. G. White; "Artificial Stone in Construction," Samuel Bachtell; "Width of Paved Roadway in City Streets," S. Whinery; "Muskingum River Bridges," T. C. Connar; "Jacksonville (Fla.) Bridge," O. Benson; "Improvement of County Roads," G. S. Innis; "Turnpike Specifications," Geo. H. Hill. There are the reports of the committees on Highways, Surveying, Drainage, Civil Engineering, Planks and Instruments, Legislation, and on a bill requiring surveyors to be licensed. A draft of the bill is also given. Copies of the volume can be obtained of the Secretary, Chas. A. Judson, Sandusky, O.

TRADE PUBLICATIONS.

AMMONIA MOTOR.—Railway Ammonia Motor Co., New York, N. Y., and Newark, N. J. 8vo, pp. 9; illustrated.

This is a description of the McMahon ammonia gas motor for street railways, a car on which system has been running for six months in the grounds of the World's Columbian Exposition. The operating expense is estimated at 7.68 cts. per car mile, against 13.35 cts. for the electric trolley system, 14.12 cts. for cable and 21.25 cts. for horses. Tests have been made in England and favorable reports made by engineers there and in this country.

LIGHT LOCOMOTIVES.—H. K. Porter & Co., Pittsburg, Pa. 12mo, pp. 170; illustrated.

This is a descriptive illustrated catalogue of light locomotives of various types and sizes for passenger, freight, suburban, switching, logging and other service; for mines, steel works, plantations, construction works, etc., and dummy engines for street railways. Dimensions are given of engines of the same class but of different sizes. Particulars of track, grades, curves, etc., are also given, together with 80 tables of hauling capacity and pages of working reports, giving class, dimensions, location, character of road, and details of

performance of a large number of engines in all kinds of service. For use in mines, arsenals, lumber yards, etc. Compressed air locomotives are made, consisting of cylindrical tanks mounted on a frame, the air from the tanks driving the engine in the same way as steam from a boiler.

ELECTRIC RAILWAY PLANT.—The Short Slow Speed Generators, The Short Single Reduction Motor. The Short Gearless Motor. Short Electric Railway Co., Cleveland, O.: Pamphlets, 12 mo.; pp. 19, 14 and 13, respectively, illustrated.

These are three well made pamphlets, treating in detail of the apparatus indicated by their titles. There are five generators, of 66 to 425 HP., and a new one of 500 HP., is to be brought out soon. There is said to be an increasing demand for the single reduction motor, the special claims for which include quiet running and freedom from sparking of the commutator. The gearless motor is finding favor on account of its simplicity, and the latest form is adapted to 30-in. wheels, and weighs only 2,300 lbs. The Short gearless motor was illustrated in our issue of Sept. 5, 1891.

SOCIETY PROCEEDINGS.

BOSTON SOCIETY OF CIVIL ENGINEERS.—At the meeting at the Society's rooms, 36 Bromfield St., on Nov. 16, Mr. E. K. Turner, late Chief Engineer of the Fitchburg R. R., will read a paper entitled, "Notes on English Railways."

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—At the meeting held at 12 West Thirty-first St., New York, N. Y., Oct. 25, the three electric railway papers read at the general meeting in Chicago last June were discussed. The titles of the papers are as follows: "Series Electric Traction," Nelson W. Perry; "A New System of Electric Propulsion," H. Ward Leonard; "Electric Railway and Motor Tests," Geo. D. Shepardson and E. P. Burch. The report of the Committee on Units and Standards was accepted, and referred to the Sub-committee on Provisional Program for the International Electric Congress of 1893.

Ralph W. Pope, Secy.

AMERICAN GAS LIGHT ASSOCIATION.—At the convention held in Boston last week, papers were presented on "Water Gas Condensation," by John M. Rusby; "Advantage of Small Gas Companies Employing Engineers," by Clement A. White. A report was presented recommending that a committee of three, of whom the president should be chairman, should be chosen by the president to consider the tar question and prices received for tar in this country, and to report what steps, if any, could be taken by the gas commissioners to increase the present low prices; the committee to report at the next meeting of the Association, which will be held at Chicago, Ill., next year. Mr. A. E. Boardman was elected President of the Association.

ASSOCIATION OF SUPERINTENDENTS OF BRIDGES AND BUILDINGS.—The second annual meeting was held at the Palace Hotel, Cincinnati, O., Oct. 18 and 19. About 30 old members were present and nearly 60 new members were elected. Committee reports were presented on "Paints for Iron Structures," "Surface Cattle Guards," "Frame and Pile Trestles and Rerailing Frogs," "Interlocking Signals," "Iron and Vitrified Pipe Culverts," "Water Tanks," "Framing Wooden Trusses and Protecting Them From Fire and Decay," and "Depot Platforms."

The report on painting recommended pure linseed oil and lead as the best paint for iron exposed to the weather. The cattleguard committee presented two reports, one favoring the pit guard, the other the surface guard. The report on pipe culverts favored iron pipe and claimed that vitrified pipe gave trouble by breaking at the ends from the action of frost. Vitrified pipe was recommended for use on sidings and in place of wooden sluice boxes at road crossings. The report on wooden bridges gave the average life of unprotected wood trusses at 7½ years, the parts which fail first being the lower chord, clamps and packers. Roofing wooden bridges was not favored, on account of danger from fire; but it was recommended that the lower chords be covered with galvanized iron run under the angle-blocks and gib plates. The cost of this covering in place is 11¼ to 15 cts. per lin. ft. The only objection to this plan is that hard oak ties are apt to break the iron covering at their edges.

The following officers were elected: President, H. M. Hall, Olney, Ill., O. & M. Ry.; Vice-Presidents, J. E. Wallace, G. W. Hinman, N. W. Thompson, C. E. Fuller; Secretary, S. T. Patterson, Concord, N. H. (Concord & Montreal R. R.); Treasurer, G. M. Reed, Cleveland, O. (Lake Shore & Michigan Southern); Executive Committee, G. W. Andrews, J. Staten, J. M. Caldwell.

The next meeting will be held in Philadelphia in October, 1893. Among the subjects on which committees will report are the following: Discipline, Turntables, Water Columns, Coaling Stations, Creeping of Rails, Bridge Guard Rails, Platforms, Bridges for Spans above 130 ft.

ENGINEERS' CLUB OF ST. LOUIS.—At the meeting on Oct. 19, Mr. W. H. Bryan read a paper on "Steam Engine Efficiency: Its Possibilities and Limitations." He called attention to the popular idea of steam engine efficiency, alluding briefly to failures which had occurred in attempting to secure expected results from high efficiency machinery. He dwelt upon the ideal engine as distinguished from the real engine met with in every-day service, and showed that the perfect engine itself is of low efficiency on account of the narrow limits of temperature within which it is possible to work. But 30% of the heat units in the steam can be utilized even by the perfect engine, working between ordinary temperatures; under which conditions but 2¼ lbs. of steam per I. HP. per hour would be required, if all the heat units in the steam could be transformed into work. The real engine is subject to still greater losses, and the limits of its efficiency were pointed out. The advantages of the multiple cylinder engine were shown, and a table giving the results of a large number of tests of existing engines was presented. Comparisons were made of the amount of steam required in pounds per I. HP. per hour for the actual as well as the ideal engine. From these results percentages of efficiency were presented in three forms: 1, the efficiency which a perfect engine would have, working between the same limits of temperature, compared with the total number of heat units in the steam; 2, the efficiency of the actual engine on the same basis; 3, the relative efficiency of the actual engine on the basis of the number of heat units which it is possible to utilize within the given limits of temperature. Attention was called to the limits of pressure and the number of expansions desirable in single and multiple cylinder engines, as established by the best modern practice. The relation between the duty of pumping engines and the efficiency of ordinary engines in pounds of steam per I. HP. per hour was also pointed out.

Arthur Thacher, Secy.

ENGINEERS' CLUB OF PHILADELPHIA.—At the meeting on Oct. 15, Mr. John C. Trautwine, Jr., presented notes on "Distribution of Pressure in Masonry Joints," showing that the true significance of the "middle third" of the joint, and of the "tension" which is said to occur when that limit is exceeded, lies in the fact that masonry joints are practically incapable of resisting tension, so that when in such a joint the resultant of all the pressures falls outside the middle third, the portion of the joint which, if capable of tension, would be called upon to exert it, is simply idle, and the entire pressure is concentrated upon the remainder of the joint, the width of which is three times the distance from the resultant to the nearest edge. Owing to this, the maximum unit pressure in such joints increases very rapidly after the middle third is exceeded; whereas, in a surface capable of resisting tension (such as a cross section of an iron bar) the maximum unit pressure increases uniformly, however far from the center of the section the resultant may fall.

Mr. Wilfred Lewis gave an account of his "Investigation of the Strength of Gear Teeth," beginning with a reference to the elementary character of the problem and the great diversity of rules adopted by many recognized authorities, and showing that although the form of a tooth had long been known to be an important factor in the determination of its strength, none of the rules in common use took account of the strength as affected by the number of teeth in the wheel or pinion. It was admitted that some diversity of opinion might reasonably exist in regard to the distribution of pressure across the teeth and the number of teeth in action; but it was argued that so long as imperfections in spacing and shaping existed, as they still do to a very appreciable amount in the highest class of machinery, the only safe assumption was that the whole load was carried at the end of a single tooth. On this basis a graphical solution of the problem was presented for each step in a series of 24 equidistant cutters, and tables were distributed showing the results obtained by the graphical method. These tables indicate the relative strength of wheels and pinions with reference to their number of teeth, and leave the working strength of the material to the judgment of the engineer. Two systems of interchangeable gearing were considered, the cycloidal system in common use, and the 20° involute form adopted by Wm. Sellers & Co. A table for the strength of bevel gears with radial flanks, and involute gears as cut by the Bilgram process, was also presented.

At the meeting on Nov. 5, a paper will be presented on "The Water Supply of Philadelphia," by Henry Leffman, M. D.

L. F. Rondinella, Secy.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the meeting on Oct. 19, the paper on the "Construction of a Cheap Dam Across the Roanoke River, Near Salem, Va.," by Oscar Saabye, M. Am. Soc. C. E., was read, and its discussion was deferred.

It was followed by a paper on "Railway Signaling as Applied to Large Installations," which was read by the author, Mr. John P. O'Donnell, M. I. M. E., of England, the discussion on which was noted in our issue of Oct. 27. On Nov. 2, the paper by Mr. Saabye, noted above, was discussed, and a paper read on "Electric Rock Blasting—the American Method," by William L. Saunders. This latter paper is a condensation of matter given at various times elsewhere, together with new information such as to make a complete presentation of the subject. The author showed the importance of simultaneous discharge of blasts, and the impracticability of such by the old methods. The form of battery and exploder used are described and the dangers from small exploders noted. A large exploder will fire even a frozen cartridge. The distribution of exploders so as to cause a high initial explosion is discussed, also methods of use. The best place for an exploder is fully treated upon; also the dimensions, position and direction of holes, and the manufacture of the exploders. Conducting wires and modes of connecting and handling them are considered. The writer does not believe in so-called blast testers, and gives his reasons, together with causes of failure in blasts. The various electric blasting machines and methods, difficulties and dangers in their use, methods of tamping, precautions adopted, limits of safety, switches, electrical resistances to govern the strength of the current, are fully described. The cost of several large pieces of work is then given, together with a discussion of the best methods of disposing of the material. The following is from a recent bulletin:

The Secretary would remind the members that the library of the Society is a reference library, and should contain the published reports of every engineering work in the land, such as municipal works; railways; canals; transportation, water, gas and irrigation works; electrical plant; important mechanical operations and improvements; expert work of all kinds; marine engineering and naval architecture; large modern buildings; geological and mining reports; and whatever can, at any time, become the subject of research by a member in any branch of the profession. Copies of such reports should be sent to the library. The value of some of the earlier papers and reports now in the library is very great, and inquiries are frequently made for them. As time passes, those of the present time will likewise increase in value. In some cases the sets in the library are not complete, and members may be able to aid in supplying the deficiencies. It is hoped that every member will put the Society library down on his list for distribution of reports, and will also give notice of important reports, not his own, which may be obtained for the asking.

COMING TECHNICAL MEETINGS.

ENGINEERS' CLUB OF MINNEAPOLIS.
Nov. 3. Secy., F. W. Cappelen, 1628 Hennepin Ave.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
Nov. 3. Secy., C. H. McLeod, Montreal, P. Q.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
Nov. 4. Secy., E. K. Smoot, 806 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
Nov. 4. Secy., O. Von Geldern, 719 Market St., San Francisco.
SWEDISH ENGINEERS' CLUB.
Nov. 5. Secy., P. Valentine. At 281 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago; Secy., John Ericson.
NORTHWEST RAILROAD CLUB.
Nov. 5. Union Station, St. Paul.
MONTANA SOCIETY OF CIVIL ENGINEERS.
Nov. 5. Secy., F. D. Jones, Helena.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Nov. 7. Secy., C. L. Annan, City Engineer's Office.
NORTHWESTERN SOCIETY OF ENGINEERS.
Nov. 8. Secy., D. W. McMorris, Burke Block, Seattle, Wash.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
Nov. 8. Secy., Chas. S. Howe, Case School.
DENVER SOCIETY OF ENGINEERS AND ARCHITECTS.
Nov. 8. Secy., Geo. H. Angell, 36 Jacobson Block.
ATLANTA SOCIETY OF CIVIL ENGINEERS.
Nov. 8. Secy., Parker N. Black, Capitol Block.
CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
Nov. 9. Wichita, Kan.
NEW ENGLAND RAILROAD CLUB.
Nov. 9. "High Speed for Trains." Secy., F. M. Curtis O. C. R. R., Boston.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
Nov. 10. Secy., Edward Mead, Norton Building.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Nov. 10. Secy., E. N. Clark, Pittsburg, Pa.
WESTERN RAILWAY CLUB.
Nov. 10. Rookery Building, Chicago. Secy., W. H. Marshall.
ENGINEERING ASSOCIATION OF THE SOUTH.
Nov. 10. Annual meeting. Secy., O. H. Landreth, Nashville, Tenn.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
Nov. 11. Secy., D. W. Meeker, St. Paul.
WISCONSIN POLYTECHNIC SOCIETY.
Nov. 14. Secy., M. G. Schinke, City Hall.
ENGINEERS' CLUB OF KANSAS CITY.
Nov. 14. Secy., Waterman Stone, Baird Building.
AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Nov. 14 to 18. Annual meeting. Secy., F. R. Hutton, 12 West 31st St., New York.
ROADMASTERS' ASSOCIATION OF AMERICA.
Nov. 15, 16, 17. Chattanooga, Tenn., and Atlanta, Ga. Secy., J. H. K. Burgwin, Grand Rapids, Mich.
BOSTON SOCIETY OF CIVIL ENGINEERS.
Nov. 16. "Notes on English Railways." Secy., S. E. Tinkham, 36 Broomfield St.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
Nov. 16. Secy., F. Collingwood, 127 East 23d St., New York.
ENGINEERS' CLUB OF ST. LOUIS.
Nov. 16. Secy., Arthur Thacher, Odd Fellows' Building.
ENGINEERS' CLUB OF CINCINNATI.
Nov. 17. Secy., J. F. Wilson, 24 W. 4th St.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Nov. 17. At Atlanta, Ga. Secy., F. A. Charlot, Macon.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
Nov. 17. Secy., C. F. Franson, Portland Block.
TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS.
Nov. 18, 201 Washington Building.
ENGINEERS' CLUB OF PHILADELPHIA.
Nov. 19, 1122 Girard St. Secy., L. F. Rondinella.
CENTRAL RAILWAY CLUB.
Nov. 23. Secy., S. W. Spear, E. Buffalo, N. Y., Iron Works.
ENGINEERS' SOCIETY OF PHŒNIXVILLE.
Dec. 6. Secy., W. Halliburton.
WESTERN SOCIETY OF ENGINEERS.
Dec. 7. Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.
NEW YORK RAILROAD CLUB.
Dec. 15. Secy., H. G. Prout, 73 Broadway, N. Y.

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GEO. H. FROST.....BUSINESS MANAGER

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The growth of the Philadelphia & Reading R. R. from a comparatively unimportant system of only about 1,200 miles to one of the largest railway systems of the country, both in the points of traffic and mileage of line operated, within the short period of ten months, may almost be called a marvel even in this age of railway financiering. In another column we have given some details of the formation and extent of this great system of railways. Of course the amalgamation of railway interests on such a scale has excited much adverse criticism as well as actual opposition and hostility, the justness of which we shall not attempt to discuss here. The avowed objects of the series of negotiations, which culminated in the control of the Boston & Maine system, have been to command the coal traffic, and to extend its markets in the manufacturing districts of New England. The possibilities of this scheme, while largely overrated, will be easily seen. The six New England states, with a population of 4,700,000 in 1890, consumed in the census year 1889, according to a recent bulletin, 11,479,953 tons of coal (about 6,000,000 anthracite and 5,500,000 bituminous), of which it produced only 2,000 tons. Here, then, is a very important market, a large proportion of which is supplied by the Pennsylvania coal fields. Of course this is not a new market or a market which any one company supplies. The new line will come into competition with no less than three important railway companies, besides the water route, for this coal business. Where this competition is with the water route the traffic will have to be taken at a low rate, necessitating a heavy tonnage to make it profitable. At the same time the new line possesses undoubted advantages over other roads for supplying certain sections and here it will get the traffic. Anything like a monopoly of the coal business by it is, however, far from probable. It must not be assumed, on the other hand, that its business will be confined to coal. The New England division of the new system covers a territory comprising some of the largest manufacturing centers in the country, while the lines west of the Hudson River penetrate the populous iron and steel manufacturing districts of Pennsylvania and afford access to the lake ports of New York. The development and interchange of traffic between these two widely varying industrial divisions seem to us to afford greater possibilities of a profitable business than the coal traffic.

In addition to the possible advantages of an all rail connection between the New England and Middle states the acquisition by the Reading interests of the control of the dozen or so of small railways embraced in the Boston & Maine system introduces a new factor into the railway traffic of New England states. Hitherto this section of our country has been a little kingdom by itself in so far as its railway system was concerned. With the possible exception of the Boston & Albany R. R., the controlling interest in which is held by the Vanderbilts, there has heretofore been no consolidation of interests, through common ownership or control of capital stock, between any of the larger New England railways and the great systems of the Middle states. That the present deal is a forerunner of further immediate amalgamation of railway interests in the two sections, as has been recently claimed, may be considered doubtful, but it at least opens up interesting possibilities for the closer connection of the railway interests controlling the territory lying on either side of the Hudson River which will result in a profit to both sections. The policy of the newly consolidated systems will have much to do with this. There are at least three other powerful systems interested in the coal and merchandise traffic between the Middle states and New England, and the adoption of an aggressive policy of diverting traffic from these by the new combination would immediately precipitate a conflict which would either result in the formation of a rival combination, of which the Pennsylvania R. R. would probably be a part, or the total disruption of the new Reading system. This, however, is largely a matter of speculation. The present indications are that the new combination has no wish to antagonize these other interests even if there is not already an understanding with them in the present movement. It is hardly necessary to say that the successful working of the new system will be of far reaching importance and will open up possibilities of great advantage to all parties concerned. The field for the interchange of commodities and traffic between the two sections covered by it is an extensive one and the new all-rail route can but facilitate such exchange.

The number of conferences or "congresses" to be held at Chicago during the World's Fair still increases, and in one instance, at least, it seems to us wisely, though on general principles we are opposed to indefinite enlargement of the program for these conferences, as stated in our issue of Oct. 6, in special subjects. The new conference, which comes somewhat late into the field, or at least, which has been somewhat late in getting started, is, as announced in another column, on "Engineering Education." There is perhaps no subject which can be more properly included in the program of congresses, if only the papers be rigidly confined to specific recommendations or recitals of fact, and weary platitudes and generalities on the general subject of education or on what the ideal education is, and the like, be rigidly excluded. There is, perhaps, no subject on which a man may cover more pages and say nothing to the purpose, nor on which there is a greater temptation to talk generalities, because many a professor may be tempted to glorify indirectly himself and his school by an implication "That is the way WE do at our school" running through his remarks, without directly saying so. If confined to specific and practical points the discussions at the convention may do good, because they will have something specific to discuss which they can do better there than elsewhere. Whereas, general scientific discussion is apt to be rather perfunctory at such a time. Where there is so much to see few will care to stop to hear much which they can just as well read at some other time. The main useful result from most of the conferences will be extension or renewals of acquaintance, but it need not be so in respect to engineering education.

In noting in our issue of Oct. 20 the assignment of Lieut. H. L. Ripley, 3rd Cavalry, U. S. A., to duty as engineer officer of the Department of Texas, the statement of a correspondent was inadvertently allowed to go in "unedited." This was that Lieut. Ripley was the first man, other than a graduate of West Point, to be appointed to the Engineer Corps of the United States Army. Details of this kind are not uncommon in the army, and very properly the best-fitted man is selected. But this assignment to engineering duty by no means permanently transfers Lieut. Ripley to the Engineer Corps; he is yet actually an officer of cavalry and in time will go back to his command. The "first" case of transfer referred to is yet to be recorded.

The numerous American and foreign comments upon the bad quality of the water supply of Chicago and its coming Exposition have led Mr. Franklin MacVeagh, of Chicago, to devote nearly a page of an article on "Chicago's Part in the World's Fair," in the November "Scribner's," to an attempt to prove that the water in question is and will be entirely above suspicion. It is even asserted that the water "is not only not bad, but is good and wholesome and delicious almost beyond comparison."

Largely through ignorance, presumably, he makes some assertions and implications that are far from the truth and need correction. After asserting that there is now and will be no trouble with the water supply, and extolling its quality as quoted above, he adds:

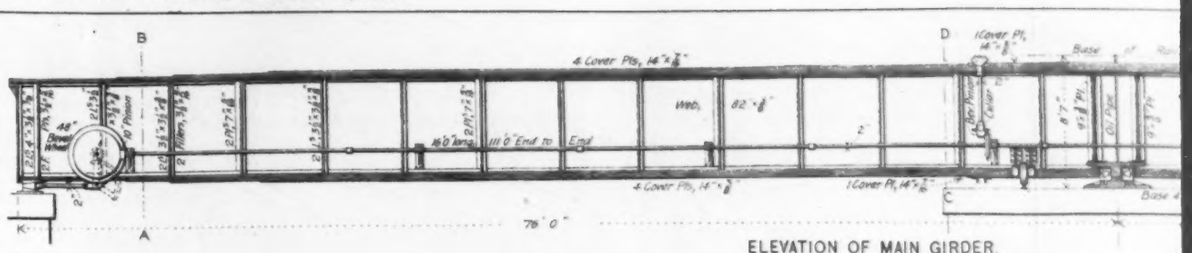
"The drainage of the city is, of course, not into the lake but into the Chicago River." He then states that the course of the river was long ago changed to flow from and not into the lake, "leaving the lake itself as pure and clean as when it was an Indian highway." The facts are that a large portion of the sewage of Chicago is still discharged into the lake, the population so contributing being estimated by residents of Chicago to be about 300,000, or at least a fifth of the whole population.

The somewhat complicated sewerage and drainage system of Chicago and the manner in which the water supply is polluted in times of flood, were set forth in detail in Engineering News of April 21 and May 12, 1892.

The new four-mile water tunnel, now nearly ready for use, but which Mr. MacVeagh speaks of as already completed, will, to a large extent, lessen the chances of pollution. But if the supply from this source will be absolutely beyond danger of contamination from the Chicago River in time of floods, why expend $30,000,000 for the new drainage canal? This expenditure, Mr. MacVeagh says, "confirms the fitness of the present system, of which it is but an elaboration meant to anticipate the demands of a city of several millions of people." Speaking of the time which must elapse before the drainage canal is completed, it is stated: "Meanwhile the new tunnels make the water supply perfectly secure." Mr. MacVeagh attributes the criticisms on the water supply of the city to disappointment because the Exposition went to Chicago. He also says that the great flood of last May was "the starting-point of the story" about the pollution of the water supply. The facts are that the present discussion regarding Chicago's water supply began on Jan. 22, 1892, more than three months before the great flood, when Prof. W. T. Sedgwick, of Boston, and Mr. Allen Hazen, of Lawrence, Mass., presented the paper before the American Statistical Association on "Typhoid Fever in Chicago," which appeared in our issue of April 21, 1892. The figures in the paper relating to Chicago's high death rate from typhoid fever, over 16 per 10,000 population in 1891, higher than any other great city of America, if not of the world, were all taken from official reports.

Mr. MacVeagh refers to the great care which the city of Chicago has always taken to protect its water supply, but a committee of the Citizens' Association of Chicago in 1885 states in a report upon the "Main Drainage and Water Supply of Chicago," that: "The sanitary history of Chicago is a history of makeshifts and expedients." Moreover, the Commissioner of Health was unaware of the high typhoid death rate in 1891, or is at least reported on good authority as having indignantly denied that there were nearly 2,000 deaths from disease in Chicago. The official records give the number of deaths from typhoid fever in 1891 as 1,997.

Chicago has had a serious problem to face and has done and is doing much to improve its sanitary condition. But there is nothing to be gained, in the long run, by trying to make either the outside world or its own people believe that its water supply is not liable to serious contamination at every flood, while the high death rate from typhoid fever can only be explained on the ground that the water is continually polluted.



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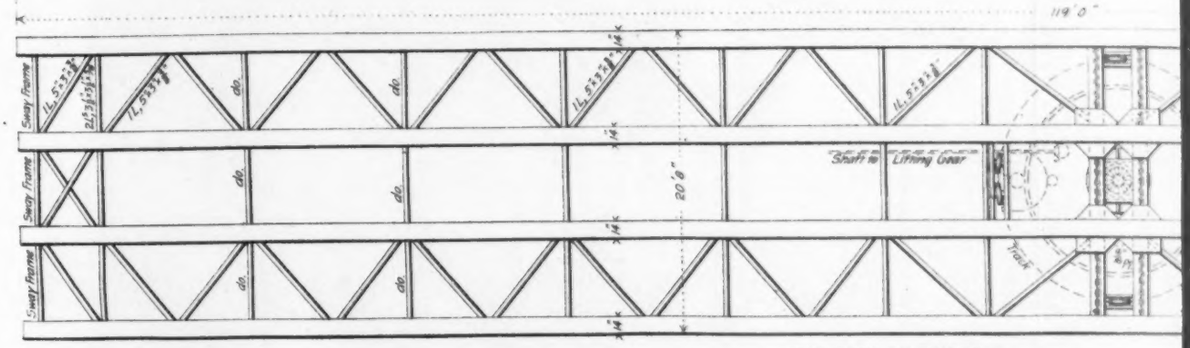

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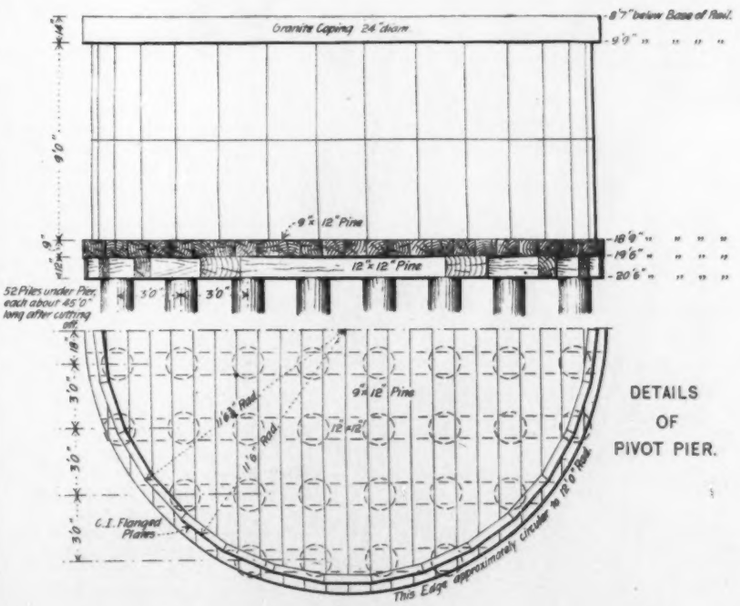

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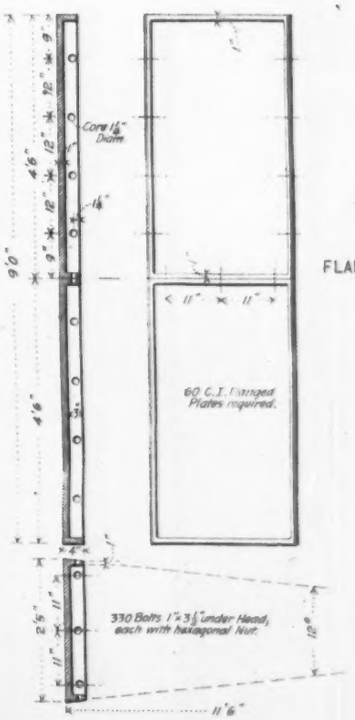

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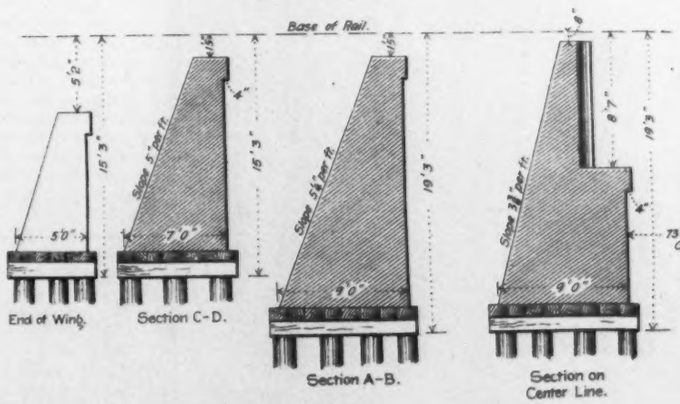

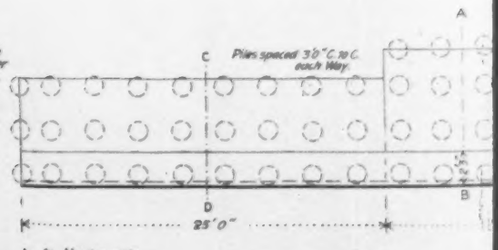

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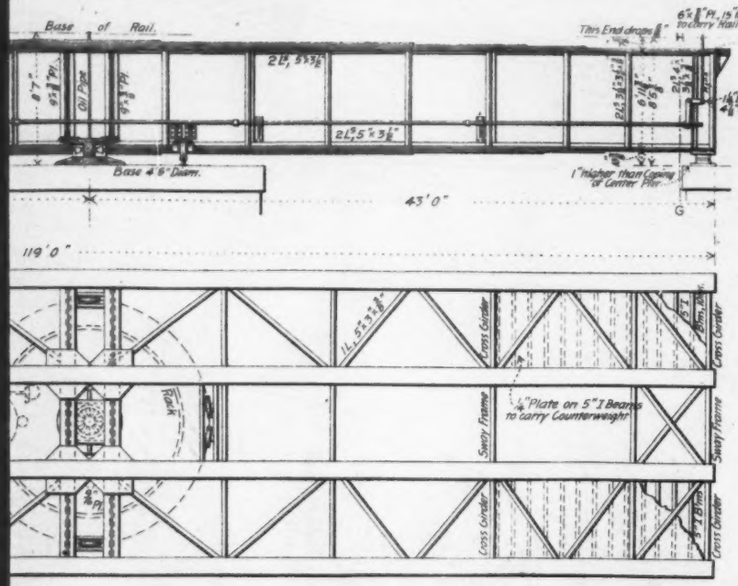
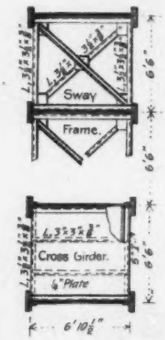
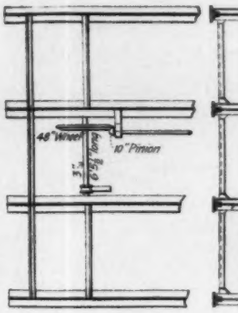
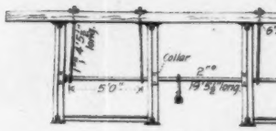
Chas. C. Wentworth, Chief Engin









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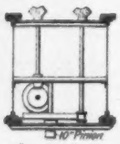

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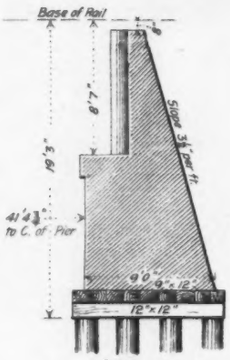

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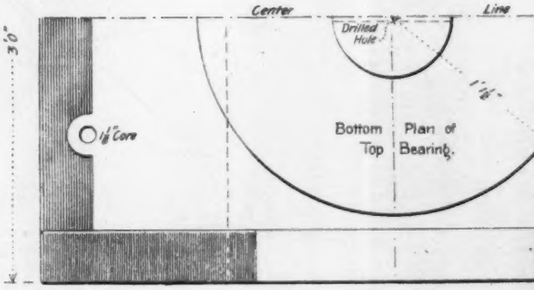

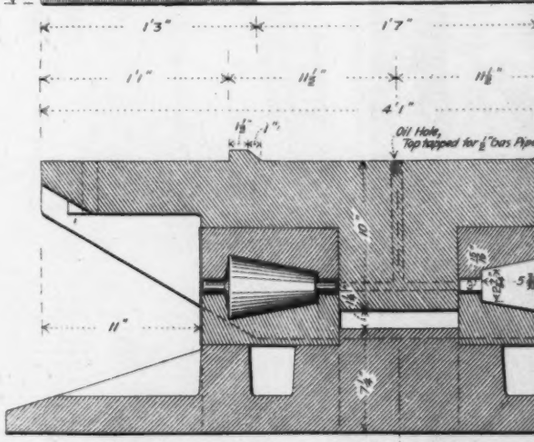

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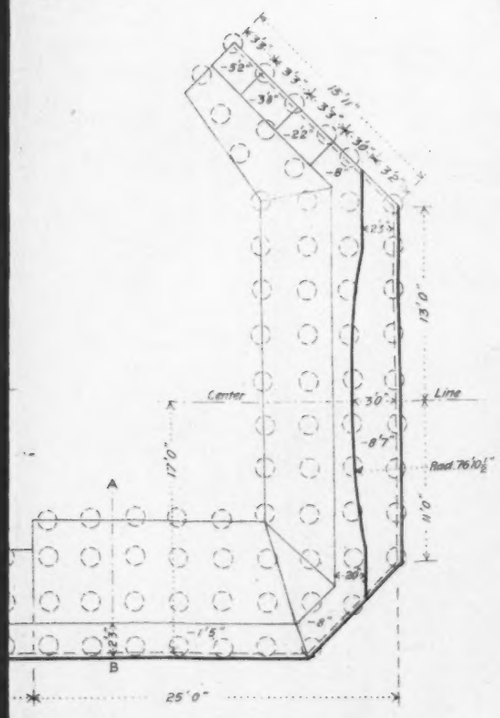

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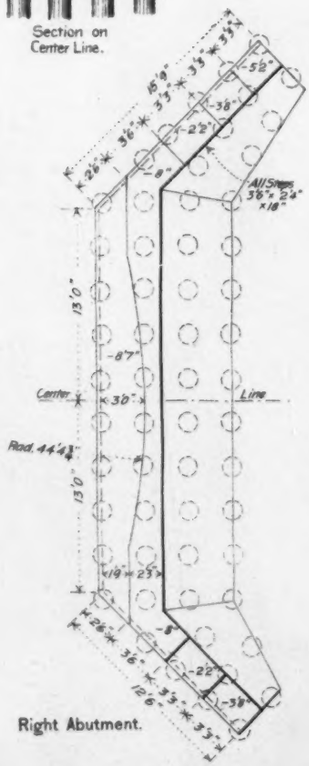

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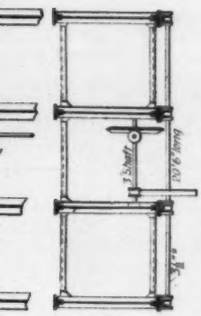
GE OVER THE DISMAL SWAMP CANAL; NORFOLK & WESTERN R. R.

Chief Engineer. American Bridge & Iron Co., Contractors.



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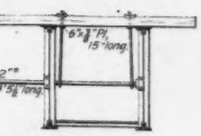

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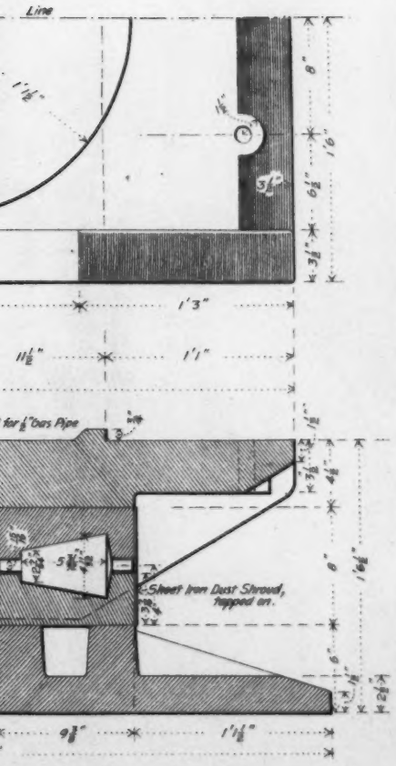


BEARING.

CHAS. HART & SONS, LITH, 26 VESEY ST., N. Y.

THE DRAINAGE OF THE KANKAKEE MARSH.

The proposed reclamation of the great Kankakee swamp in northern Indiana, a tract of land half as large as Rhode Island, is described elsewhere in this issue and is a problem in engineering of great interest. The task is, briefly, the control of a river having an average flow of 500 cu. ft. per second in its course through a marsh 90 miles long, the drainage from which more than doubles the volume of water to be disposed of. This drainage must be so provided for as to reclaim the lands and fit them for cultivation.

That sooner or later some system of drainage will be carried out on this great tract hardly admits of question. Indeed, it seems certain that even at the present time the value of the reclaimed lands would much more than cover the cost of improvement, and as their potential value is increasing year by year with the growth of cities in their vicinity, and the cost of dredging and earthwork is steadily decreasing, the time must come when the chances for profit in the enterprise will be so evident as to admit of no further delay.

There is room for wide differences of opinion among engineers as to the best plan to be followed in carrying out this work. The plan proposed by Mr. W. M. Whitten, Chief Engineer of South Bend, Ind., which is elsewhere described, presents some novel features and is worth careful study.

The drainage of the Kankakee marsh is of especial interest in connection with the water supply and drainage of the city of Chicago, distant about 40 miles from the lower end of the swamp, as shown by the map elsewhere in the issue. The new drainage canal for Chicago, work on which has just commenced, is designed to discharge a total volume of 10,000 cu. ft. per second into the Des Plaines River. The effect of this increased flow in raising the flood level of the Illinois River all along its course is a problem which the engineers of the Chicago Drainage Board are now studying. It is worth while noting that the drainage of the Kankakee swamp when carried out may have a noticeable effect upon the floods in the Illinois valley. The Kankakee River joins with the Des Plaines to form the Illinois River at a point about 15 miles below Joliet, the outlet of the new drainage canal. The volume of flow from the Kankakee is now remarkably uniform for a stream with no large lakes on its watersheds. According to the best available figures, the mean flow of the Kankakee at Momence, the foot of the swamp, is 1,271 cu. ft. per second, and the maximum flood flow is 36,084 cu. ft. per second, a ratio of 1 to 28.4. According to Fanning the ratio for ordinary streams of this size is 1 to 74. It is doubtless true that the great percentage of the watershed which is covered by swamp is the reason for this uniformity of flow. The whole swamp is inundated in high water, and the level surface, thickly covered with vegetation, drains off very slowly.

But when the whole swamp is drained and under cultivation the rainfall will drain off from it as rapidly as from any other tract of cultivated land of similar slope and character of soil. The swamp will no longer be a great shallow storage reservoir to hold the floods which pour down from other parts of the watershed. It is certain, then, that when the drainage enterprise is carried out, a considerable increase in the flood volume of the Kankakee will result. The exact amount of the increase it will be the duty of the engineers of Chicago drainage canal accurately to determine, for in future years, when the compensation for flood damages in the Illinois valley arises, the increased flow from the Kankakee must be considered as well as that from the Chicago River.

It is important to notice in this connection Mr. Whitten's proposal that in draining the marsh, provision shall be made for irrigation. This could be done at the same time the excavations for the drainage canals were made at a small increase in the expense, and he considers that the increase in value of the land due to the irrigating facilities would equal the increase due to its drainage. It is well known that protracted droughts are the bane of the farmer in this region, and certainly these lands with their deep soil when well drained and provided with a water supply which will make them independent of fluctuations in the rainfall should far excel in value the most valuable prairie farms of Illinois and Indiana.

Now if the provision for irrigation includes facilities for the storage of part of the rainfall, it is evident that the increase in the flood volume will not be as great as if the drainage work were carried out alone. Probably it would not be feasible to make the capacity of the storage reservoirs sufficient to store a very large percentage of heavy rainfalls, but some gain would doubtless be made.

There is still another aspect in which the Kankakee watershed is of interest to Chicago. At the last meeting of the Indiana Academy of Science, Prof. John L. Campbell contributed a paper showing the advantages of the Kankakee as a source of water supply for the city of Chicago. In it he states that notwithstanding the fact that the Kankakee River flows through a vast swamp, its water is clear and of excellent quality for domestic use. The iron and possibly other mineral substances held in solution give the water valuable tonic properties. The exceptional healthfulness of the Kankakee region compared with other large swamp districts may be due in great measure to these mineral qualities. In a personal letter to us, Prof. Campbell says:

> The Kankakee at the point where it is nearest to Lake Michigan has an elevation above the lake of 73 ft. The distance from this point to Chicago is about 40 miles. A gravity channel is entirely possible. The water is pure and the supply ample for a great city.

It must be foreseen, however, that when the marsh is drained and brought under cultivation, it will support a thickly settled farming population and possibly many towns and villages.

The water will then inevitably be more or less contaminated with organic impurities, and will hardly be fit for city water supply. Moreover, Chicago has now expended great sums to secure pure water from Lake Michigan, and has begun another large enterprise for the same purpose in the construction of her great drainage canal. It is quite unlikely, therefore, that she will give serious consideration to other sources of water supply.

STEAM VS. HOT WATER IN CAR HEATING PIPES.

The paper on steam car heating by Mr. A. M. Waitt, published in our issue of Sept. 29, is doubtless the most important defense of direct steam heating as compared with indirect or hot water heating which has yet appeared. Mr. Waitt charges that the indirect system gives trouble from cold cars, lack of circulation, frozen traps and burst pipes. The only fault which he finds with the direct steam system is overheating the cars in mild weather, and this he says is due chiefly to too much radiating surface and the use of valves which do not permit any graduation of the amount of steam admitted. With the direct steam system now standard for passenger coaches on the Michigan Central the radiating pipes consist merely of two lines of two 2-in. pipe running the length of the car on each side, a far simpler and cheaper method of piping than the old plan of placing spurs under the seats. A special valve is used for admitting steam which allows accurate graduation of the flow. A full turn of the hand wheel gives an opening of only 1-100 sq. in. area. With such close regulation of the flow it becomes possible to cut it down to suit the demand for heat. In very mild weather the pressure in the radiating pipes may be made to fall below the atmospheric, in which case the temperature may be made less than 212°. Of course when this occurs the condensed water will gradually fill up the pipes until the radiating surface is reduced enough to correspond to the rate of flow of the steam through the valve.

There is no apparent reason why close regulation of the heat by this system should not be possible, since it accomplishes practically what has been before aimed at by inventors working in other directions, viz., the regulation of the heat by varying the amount of radiating surface.

On the other hand it is not quite clear that Mr. Waitt's arraignment of the indirect or hot water heating system on various grounds is justifiable. The trap, which Mr. Waitt condemns, is no more necessary with the indirect than with the direct system. Lack of circulation in a hot water system can hardly occur if the piping is properly arranged and the steam flow is made to act as an ejector to make the circulation positive. As for freezing pipes, it is of course true that the pipes in a hot water heated car must be drained if the car is laid up in cold weather, but so they must in the direct steam system, since condensed water collects in them in considerable amount.

Because Mr. Waitt in trying indirect systems of heating had trouble with cold cars, lack of circulation, and frozen traps and pipes, it does not follow that these are inherent defects of the indirect system of heating. They may have been due to the special design of the systems tried.

It is worth while to contrast the really essential differences between the direct and the indirect systems of steam car heating. In the first place the temperature of the radiating surface will generally be higher with the direct system, for the pipes are filled with the steam itself. In the indirect system the steam is condensed as it comes in contact with the circulating water, which fills the pipes and is, of course, at a lower temperature than the steam. It is probable that the difference in amount of radiation between steam and hot water pipes is even greater than that due to their difference of temperature. The steam circulates far more freely and imparts heat readily to the pipes by its condensation against them. The hot water heats the pipes only by direct conduction. It was doubtless ignorance of this fact that led the early designers of direct steam heating systems into the mistake of providing too great radiating surface. They were familiar with the work of piping cars for the Baker and other hot water heating systems and did not appreciate the greater radiation from pipes filled with steam.

It follows from the above that a hot water or indirect system requires a larger extent of heating surface than the direct steam system, and is on this account a little more expensive in first cost. Has it any practical advantages over the direct steam system to offset this?

The chief advantage which has been claimed for the indirect system is the facility with which the heat can be regulated. As Mr. Waitt explained in his paper, with the direct steam systems hitherto placed on the market it has not been possible to regulate the flow of steam into the radiating pipes to correspond with the demand for heat. An opening of only 1-64 sq. in. area will pass a pound of steam per minute, an amount sufficient to comfortably warm an ordinary passenger coach with the outside temperature far below freezing. That the use of a valve which permits close regulation of the steam flow will overcome the chief difficulty which has been experienced with the direct steam system seems entirely reasonable; but Mr. Waitt evidently does not claim that the results obtained in the way of regulation will be quite equal to those secured by the hot water system, since he recommends the latter as the only practicable system for sleepers. The reason for this is that with the steam flow throttled down below the rate of condensation, water gradually accumulates in the pipes and partially fills them. Thus the heat is concentrated in one part of the car, an objection of not much importance in a coach, but of great importance in a compartment car or a sleeper.

But even though the direct steam system be approximated to the indirect in the matter of regulation, there are other essential differences between them which are worth noting. The indirect system has a quantity of stored heat in its pipes, sufficient to keep the car comfortably warm for an hour perhaps, when the engine is detached. This may sometimes make unnecessary the provision of an extra steam supply when the car stands for a short time at the end of its trip. Of course if it is to stand a considerable length of time, the water must be drawn off to prevent freezing and no advantage is gained from the stored heat.

Another advantage of the indirect system is that it offers facilities for the use of independent heaters in connection with the radiating pipes. These can be used to keep the car warm when it is not in service. Of course a road with heavy traffic using the direct system will generally find it cheaper to establish stationary plants wherever its cars are laid up to keep them warmed. On the other hand a road with light traffic could not afford a stationary steam plant at every point where a few cars are laid up, and would probably pursue the most economical course by using independent heaters in connection with a hot water system

and keeping fires in the cars while they stand in the yards.

Another essential advantage of the indirect system follows from the fact that its radiating surface is at a lower temperature. There is less of the "choky" smell produced by the heating of the dust which accumulates on hot steam pipes. Probably not much importance will be attached to this except for sleeping and parlor service. The traveling public is so well accustomed to the stifling air from hot stoves and furnaces that it will hardly discriminate closely between steam and hot water heating as far as the quality of the air goes. Ventilation and cleanliness will make either system quite near enough to perfection in this respect.

To offset these advantages of the indirect system we have for the direct steam system the important advantages of simplicity and less first cost, with the fact that a cold car can be warmed by it in far less time than with the hot water system. This last feature is so important that it has given direct steam undisputed first place as the system for suburban cars. It is true that some of the hot water systems can be made to operate as direct steam systems while the pipes are filling with condensed water, but in suburban traffic the car would frequently be at the end of its trip by the time the apparatus was ready to operate as a hot water system. The advantages over the plain direct steam system in this case are not apparent.

In view of Mr. Waitt's statement that the Vanderbilt roads have definitely adopted direct steam as the standard system of heating for passenger coaches, it is amusing to recall the hue and cry which was made by high officials of the principal Vanderbilt road less than two years ago concerning the dangers of direct steam heating. Apparently the fears then expressed have been permanently set at rest, as was to be expected. Probably none now would venture to claim that the "dangers" of direct steam were of enough importance to be considered in comparing its merits with those of the hot water system.

The merits of painted sheet iron and the ordinary unpainted Russian iron for locomotive boiler jackets are being tested on the New York, Lake Erie & Western R. R. A ten-wheel passenger engine has been painted Tuscan red to accord with the standard color of the passenger cars on that road.

The overhead trolley wire system of electric traction may be introduced in Glasgow, Scotland, the street railway committee of the corporation having advertised for proposals for equipping certain lines with this system. The lines are owned by the city. Mr. John Young is General Manager.

The National League for Good Roads was organized at Chicago on Oct. 20. About 1,000 persons interested in the improvement of country roads were present at the preliminary meeting. The constitution adopted states that the purpose of the organization is to awaken general interest on this subject, to determine the best methods for building and maintaining roads, and to secure such legislation, state or national, as may be necessary. There are no initiation fees or dues to the League, other than an annual payment of 50 cts. for defraying the expenses of publishing the "National League," the official organ. Judge E. H. Thayer, of Iowa, was elected Permanent Chairman, and S. K. Thornton Prime, of Dwight, Ill., was made Permanent Secretary. Gen. Roy Stone, of New York, in the opening speech made one remark that is particularly pertinent. He said that, "Columbus discovered America in vain, if after 400 years we are still behind the ancient Peruvians—in road making—and are not ashamed of it."

The street railways of several cities in Great Britain have been acquired by the municipal authorities, a course recommended by a committee of the House of Lords in 1879, though the committee did not think that the lines should be worked by the authorities. The corporation of Manchester owns 26 miles of street railway; Birmingham, 19; Liverpool, 28; Glasgow, 30; Newcastle, 11; Bradford, 14 miles. Altogether about 243 miles of street railway are owned by different local authorities in the United Kingdom.

Our report of the Meneely tubular bearing, in our issue of Sept. 29 (p. 299), contained a typographical error, the figures for coal consumption on the two trains being transposed. The correct figures are:

Train with ordinary bearings..... 14,800 lbs.
Train with tubular bearings..... 11,100 lbs.

Each train contained four cars and weighed 102 tons, exclusive of engine and tender.

SEWAGE PURIFICATION IN AMERICA.

(Continued from page 369.)

Wayne, Pa.

Wayne is a suburban residence village about 15 miles from Philadelphia, on the Pennsylvania R. R. It has been built up by Messrs. A. J. Drexel and Geo. W. Childs, who bought the "Wayne estate" some years ago. In June, 1890, its population was 997. Two years later a population of 2,000 was claimed. There are no manufactories.

Water-works were built by Drexel & Childs in 1881. Very shortly after Col. Geo. E. Waring, M. Inst. C. E., was engaged to extend the sewerage system of the village which then conveyed the wastes and roof water of a few buildings into a brook flowing through the valley.

Col. Waring extended the system on the strictly separate plan, collecting the sewage in a large flush tank from which it was discharged into the brook through an 8-in. pipe 2,925 ft. long, having a fall of 1 ft. in 400. An additional area being secured later a 12-in. outlet was laid parallel to the lower part of the first outlet.

The brook which received the sewage had a copious flow and discharged into Darby Creek, a stream polluted by manufactories. The brook gradually became fouled, to prevent which the sewage was finally delivered into a settling basin before passing to the brook. The effluent not being sufficiently cleared by this settlement it was discharged into a second, and later into a third settling basin.

The farm land along the brook gradually being taken up for residences complaints regarding the fouling of the stream increased and finally an injunction to prevent the discharge of sewage into the brook was threatened. When the works described below were recommended by Col. Waring in the spring of 1891, the move for an injunction was stopped under verbal protest.

Surface irrigation on somewhat isolated land at the lower side of the estate was decided upon. The disposal area is thus described by Col. Waring in an article in the "American Architect" of July 2, 1892:

> The tract to be used was of unfavorable character, but it was the only one available. It consisted mainly of an old pond surrounded by ancient pollard willows, a large area of swamp through which the brook meandered, about four acres of slightly sloping cleared land, and a very steep, thickly wooded and rocky hillside, rising about 100 ft. from the level of the brook to one corner of the nearly square tract.
>
> The pond was obliterated, the willows and much other vegetation were cleared away, the brook was confined within stone walls and all except the steep hillside was thoroughly underdrained.

The disposal area includes eleven acres divided by the creek as shown in Fig. 37. Along the lower course of the brook much of the land was a nearly level tussock swamp. All growth less than 8 ins. in diameter was removed from the tract. The creek was straightened and deepened and the banks sloped back from the walls of the creek and sodded. But little grading was necessary on the left or south side of the creek, but the whole area on the other side was graded. The header drain of 6-in. pipe on the left side of the creek was laid to cut off the effluent from some slightly wet land. The stone drain is for the protection of the pumping station.

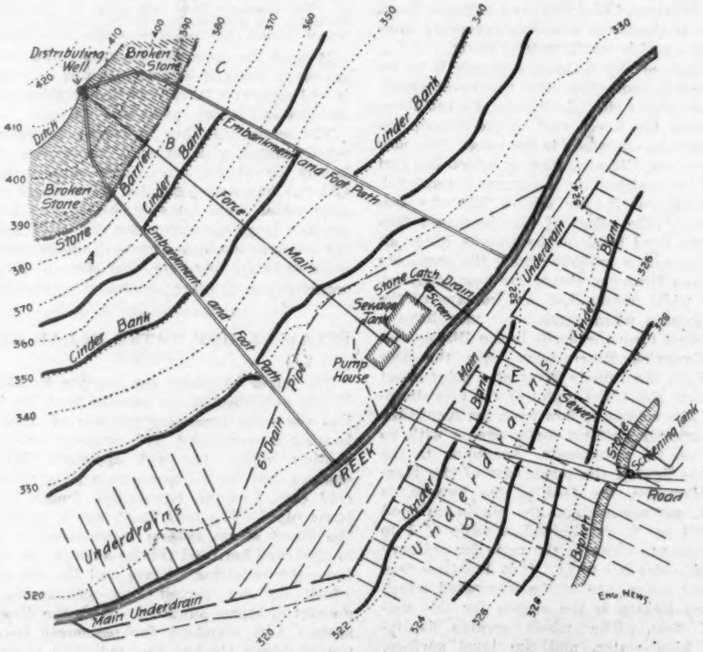


FIG. 37. PLAN OF SEWAGE DISPOSAL AREA AND WORKS; WAYNE, PA.

The land on the south side of the creek was divided into three nearly equal tracts by embankments about 1 ft. high, which converge at the distributing well. A road to the pumping station divides the land on the north side of the creek into two sections.

The outlet sewers already described were intercepted just above the old settling basins, from which point a 12-in. vitrified pipe with a fall of 1 in 125 extends to the edge of the disposal field. About 400 ft. above the edge of the field an 8-in. branch with a fall of 1 in 250 extends to a screening chamber. From this chamber the sewage is delivered at will onto tract D, or E, first passing over a bed of broken stone. The cinder banks on both sides of the creek are described further on.

The main outlet sewer is of vitrified pipe where in earth and of iron and cement where on piers. It ends in a brick screening chamber with a concrete bottom near the pumping station, shown in plan and section by Fig. 38. After passing through the screens the sewage flows into the receiving reser-

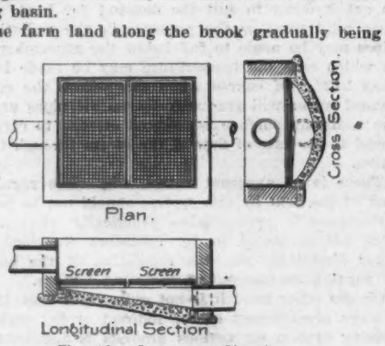


Fig. 38. Screening Chamber.

voir shown in plan and longitudinal section by Fig. 39. This reservoir has a capacity of 90,000 gallons to the mouth of the inlet pipe. Its bottom is of concrete and slopes toward the sump into which the suction pipes extend. Six 6-in. pipes at the top of the tank lead to the creek as an overflow.

Two Barr duplex pumps with a capacity of about 22,000 gallons each per hour, or 525,000 gallons per day, force the sewage up the hill on the left of the creek to the distributing well. This 12-in. force main is of spiral weld steel pipe, is 480 ft. long and has a rise of about 100 ft. The lower end of the force main was placed above ground to obtain a grade that would allow it to drain dry through the aerating pipe, mentioned below.

Both pumps are started when the screening reservoir is nearly full, and the sewage is first delivered back into the receiving tank through a 4-in. aerating pipe, the object being to deodorize the sewage and increase its oxygen. Aeration is maintained for from 60 to 90 minutes, after which the valve in the aerating pipe is closed and the sewage is delivered into the well.

The distributing well is shown in plan and section by Fig. 40. It is of brick, with a concrete bottom, and is covered by a small building shown in the distance in the view, Fig. 42. Lift gates, working in the masonry of the well, are provided to regulate the discharge of the sewage upon the tracts.

A bed of broken stone about 8 ins. deep and 50 ft. wide extends across the tract below the distributing well. Sewage is discharged into a depression along the upper edge of the stone bed. When this depression is filled the sewage flows down the bed, which has a fall of about 1 to 4, to a catch wall of broken stone designed to check the somewhat rapid flow of the sewage and to distribute it evenly over the land below.

The cinder banks shown in Fig. 41, are laid on graded strips following contours. The cinders, mostly from locomotives, are backed, to prevent washing, as shown by Fig. 41. These banks are designed to catch the sewage in its irregular flow down the steep hillside and start it again uniformly. Some of the sewage filters through the banks during the application of sewage to the fields, and all of it passes through when sewage is diverted to another tract.

Small and shallow carriers are cut with spades through all the disposal area to help equalize the flow of the sewage, in addition to the cinder banks.

The receiving reservoir fills in from 6 to 12 hours and is emptied in about five hours. The sewage disappears from the surface of the land in about a half hour after the pumps are stopped.

The field on the left side of the creek was put in operation in September, 1891.

The field at the right of the creek was put in use later, before well covered with vegetation. Col. Waring states that if the aeration of the sewage, as described above, proves sufficiently beneficial, a force main will be constructed to the field at the right and sewage delivered to it by pumping, instead of by gravity, as now.

Col. Waring makes the following statement regarding a visit to the disposal area in the summer of 1892.

July 1, I went to Wayne with the Sewerage Commissioner of a New England town, who desired to inspect the work. It was found that in June the broken stone tracts at the top of the hill had been forked over, and about six yards of fibrous matter removed. This was thrown in a heap, and had at no time been offensive. There remained among the stones a certain amount of half decomposed material, mainly paper fiber.

As the sewage was discharged at the upper edge of the stone tract, it was milky-looking water, such as flows in the gutters in the better parts of Baltimore. As it escaped from the stone tract, it was considerably blackened with carbonaceous refuse. It had no increased odor. This blackened appearance was entirely lost before the first barrier (x) was reached. As the water gathered behind the lowest barrier it was perfectly clear. A little below this, where a rill had gathered, the Commissioner filled a glass with it. Holding it to the light, he saw that it was absolutely clear; smelling it, he found it without odor; and tasting it, he found it without taste. The condition of the field had, at no time, been more satisfactory than on that occasion, and the man in charge said that it was getting better and better every day.

Most of the above information is abstracted from an article by Col. Waring which appeared in the "American Architect" of July 2, 1892. The illustrations, Figs. 37 to 41, with some changes, are from the same source. The views, Figs. 42 and 43, were reproduced from photographs kindly sent by Col. Waring, who added some information to that given in the above named article.

Oct. 27, 1892, the writer visited the Wayne purification works, and through the courtesy of Mr. Frank Smith, manager of the Wayne estate, and Mr. C. D. Slaw, Superintendent of the sewer-

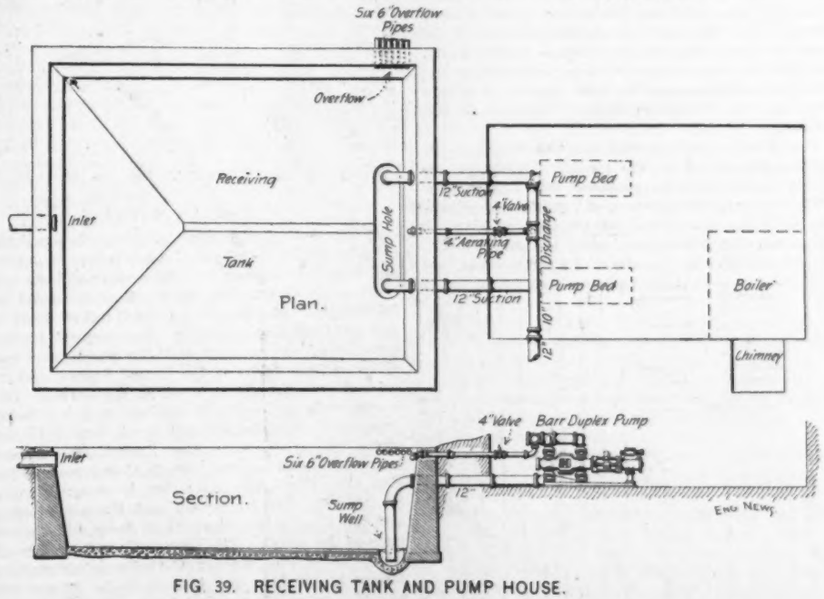


FIG. 39. RECEIVING TANK AND PUMP HOUSE.

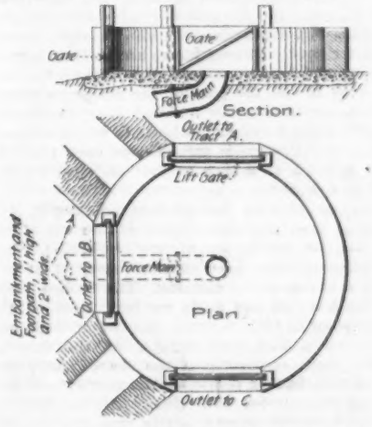


FIG. 40. DISTRIBUTING WELL.

FIG. 41. CROSS SECTION THROUGH CINDER BANK.

FIG. 42. GENERAL VIEW OF WORKS FROM NORTH SIDE OF CREEK.

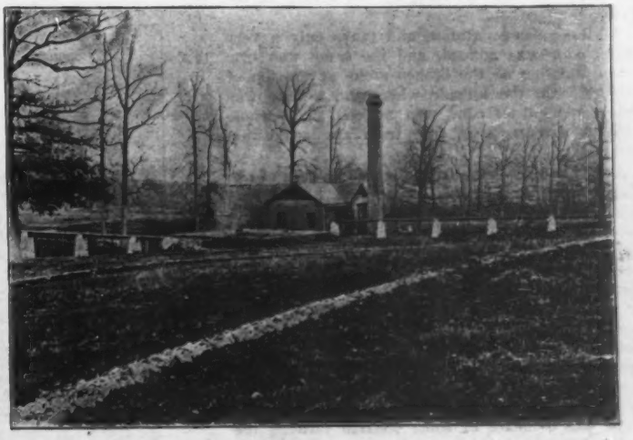


FIG. 43. GENERAL VIEW OF WORKS FROM SOUTH SIDE OF CREEK.

age system, obtained the additional information which follows.

There are now about 600 acres in the estate. All buildings on the property are connected with the sewerage system, there being about 275 connections at present. No charge is made for connections with the sewers and no yearly rentals are charged except in the case of a few connections from buildings outside the estate. The average daily consumption of water in Wayne is stated to be about 200,000 gallons. The average pumpage was given as about the same, but from all the data at hand it would seem to be higher. Two days out of five, according to the information given, the sewage flows by gravity onto the north part of the area.

The first screens used at the screening chamber at the receiving reservoir had a 2-in. mesh. This mesh proved to be too coarse, and screens with 1-in. mesh are now used. The rakings from the screens average about two barrels a day, there being more on Saturday, Sunday and Monday than any other day. Lime is put upon the rakings as they accumulate beside the chamber before removal.

The pumping station is kept open throughout the 24 hours and the pumps are run from 16 to 18 hours a day, requiring about 110 lbs. of buckwheat coal per hour. Two engineers are employed at the station and Superintendent Slaw divides his time between it and the part of the sewerage system within the village. In addition laborers are employed when necessary, which, it would seem, is not often. Sewage is turned upon each tract for only one day at a time so that each tract has a rest of five days.

The material in the barriers has never been changed and the broken stone at the top of the hill on the south side of the creek, Mr. Slaw stated, has never been cleaned except that one section has had one cleaning. The broken stone at the head of the areas on both sides of the creek showed only a small amount of rags and paper which had been caught. At the dam of broken stone at the top of the steep hillside and at the first barrier below sludge accumulates and has to be shoveled out. Except at the first, or stone, barrier the sewage rarely runs over the top of the banks, unless they are stopped by leaves, as is likely to be the case just at this time of the year. The sewage has a tendency in the first part of its course to run down the steep hillside in channels and to some extent this has been encouraged, or rather several small channels have been formed in order to keep the sewage from flowing down in one large one.

There was scarcely any trouble from frost last winter, the little occurring at one corner of the field.

At the pumping station and tanks only a very slight odor was noticed, and the same was true when standing on the broken stone at the top of the hill. On the hillside where the sewage was being applied no odor was noticed. The whole area was remarkably free from any suggestion of sewage.

As the sewage came from the middle gate of the distributing well at the top of the hill it was cloudy and like any sewage not affected by manufacturing wastes. At the second barrier, counting the dam of broken stone as one, little change was noticed, perhaps because the sewage came quite directly and rapidly from the first through two or three channels. At the third barrier the sewage was clearer and a dog drank freely of it. Behind the fourth barrier a clear looking liquid four or five inches deep was found. Below the last barrier no sewage could be seen. At Iphan Creek, which flows through the grounds, there was evidence of some seepage through the walls of the creek below the section which was receiving sewage, but the seepage was slight and might have been natural. At the ends of the drain and trench of broken stone no effluent was discernible. The creek showed no signs of pollution by the effluent, and small fish were observed in it.

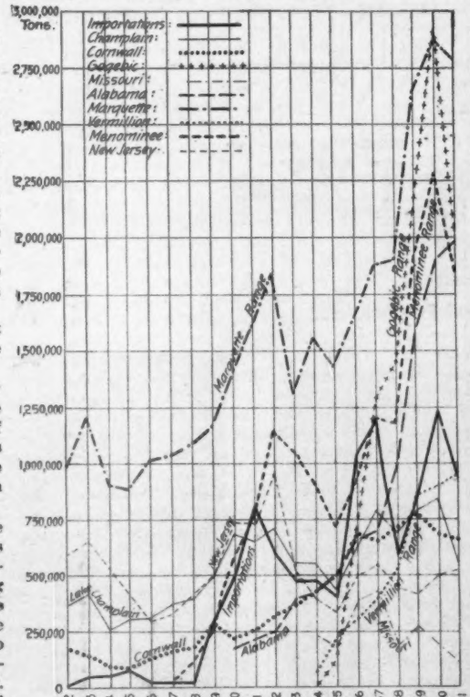
In the pumping station there was a corked bottle of sewage taken in August, 1891, after having passed through three barriers. It was slightly flocculent at the bottom and on being uncorked gave off a faint odor. In Mr. Smith's office was another corked bottle of the effluent, said to have been taken Aug. 31, 1891, which appeared to be clear and colorless and was without odor.

At least five crops of grass were raised on each side of the creek in 1892, and a man was engaged in raking up a fair crop of grass from the field north of the creek on the day of the writer's visit, Oct. 27.

TWENTY YEARS OF IRON ORE PRODUCTION.

The accompanying diagram shows the annual output in long tons from each of the principal iron ore producing districts in the United States, according to the statistics collected by Mr. John Birkinbine, President Am. Inst. M. E., for the U. S. Geological Survey. Where exact statistics were not to be had, careful estimates were made. The most interesting feature of the diagram is the enormous increase in the output of the Lake Superior ores. Twenty years ago the Marquette range produced in round numbers about 950,000 tons, or about as much as Lake Champlain and New Jersey together. In 1891 the united product of the Marquette, Menominee, Gogebic, and Vermillion districts was over 7,600,000 tons, or more than half the total ore production of the United States. The Marquette range was the first of the enormous Lake Superior deposits to be developed. In 1877 the first shipments were made from the Menominee mines; and in 1884 the ore from the Gogebic and Vermillion ranges appeared in the market.

The South stands second only to Michigan in the importance of its ore product. Alabama, as shown in the diagram, produced last year nearly 2,000,000 tons. The product of Virginia, Tennessee and Georgia, with about 85,000 tons from Kentucky and North Carolina, bring the total Southern production up to about 3,450,000 tons, or



Twenty Years of Iron Ore Production in The United States.

nearly one-fourth of the total production of the United States. Pennsylvania and New York each produced a little over 1,000,000 tons, and New Jersey about half as much. The Cornwall ore bank furnishes over half of Pennsylvania's output, and the Lake Champlain ore beds, half of New York's.

In the accompanying table is shown the amount in gross tons of each class of iron ore produced in each state in 1891. The classification of the ore is explained as follows:

1. Red hematite includes all anhydrous hematites, although known by various names, such as red hematite, specular, micaceous, fossil, slate-iron ore, martite, blue hematite, etc.

2. Brown hematite includes the varieties of hydrated sesquioxide of iron, recognized as limonite, gothite, turgite, bog ores, pipe ores, etc.

3. Magnetite includes those ores in which the iron occurs as magnetic oxide, and including some martite, which is mined with the magnetite.

4. Carbonate includes those ores which contain a considerable amount of carbonic acid, such as spathic ore, blackband, siderite, clay-iron stone, etc.

Iron Ore Productions in the United States in 1891.
(Amounts given in tons of 2,240 lbs.)

States.	Hematite. Red.	Brown.	Magnetite	Carbonate.	Total.
Mich...	5,445,371	457,597	224,123	.....	6,127,091
Ala....	1,524,783	462,047	.....	.....	1,986,830
Penn...	162,683	263,894	727,290	19,052	1,272,928
N. Y...	153,723	53,152	782,729	27,612	1,017,216
Minn...	945,105	.....	.....	.....	945,105
Va.....	3,274	653,342	2,300	.....	658,916
Wis....	527,705	61,776	.....	.....	589,481
Tenn...	396,883	147,040	.....	.....	543,923
N. J...	3,850	3,840	517,922	.....	525,612
Ga.....	45,027	205,728	.....	.....	250,755
Colo....	6,940	99,253	4,749	.....	110,942
Mo.....	99,518	7,431	.....	.....	106,949
Ohio....	.....	.....	.....	104,487	104,487
Ky.....	.....	45,111	.....	19,978	65,089
Tex.....	.....	51,000	.....	.....	51,000
Mass...	.....	47,502	.....	.....	47,502
N. Mex.	.....	1,000	38,776	.....	39,776
Md.....	.....	19,400	.....	17,979	37,379
Conn...	.....	30,923	.....	.....	30,923
Ore.....	.....	29,018	.....	.....	29,018
N. C....	.....	.....	19,210	.....	19,210
Mont...	8,536	4,000	.....	.....	12,536
Utah...	4,000	8,000	.....	.....	12,000
W. Va..	.....	6,200	.....	.....	6,200
Idaho...	.....	400	.....	.....	400
Totals	9,327,398	2,757,564	2,317,108	189,108	14,591,178

CANADIAN NOTES.

A trip through the provinces of Quebec and Ontario in September afforded many points of general and technical interest, and from notes and observations made during this trip we have compiled the following article, which we shall follow later by one on Canadian railways. The general characteristics of the country and the people are very different from those of the United States, and are evident immediately on crossing the border. This is especially noticeable in Quebec, with its French population. The houses and people are of French types, the street signs are French, the French language is spoken, and there is thus a general foreign air. The same distinction, however, is noted in Ontario, with its Scotch and English accents, and the English peculiarities of dress and appearance of the people. The French-Canadian element, which is strictly Roman Catholic in religion, is strong in Quebec, and is said to be slowly but steadily extending westward through Ontario, by no means to the satisfaction of the Canadian and British element.

Naturally the question of annexation came up quite frequently, and though many people believe that it will come eventually, it seems to be looked upon as something remote and indefinite. On the other hand a railway man stated that land values are declining and business is becoming so depressed that annexation is the only thing that can save the country from ruin. According to his views, England will protect Canada in case of threatened war or invasion, but otherwise leaves the country to itself, and thinks but slightingly of the country and its people. The average Englishman, he claimed, hardly knew the difference between Canada and the United States, or the difference between the peoples, and as matter of fact we know personally that it is not uncommon for people in Canada to receive letters from England addressed to "Ontario, United States," or even "Ontario, Canada, United States." This gentleman's views are probably somewhat extreme, but certainly contain many elements of truth. If the Canadians would do more for themselves in developing the country, instead of relying so much on English and American capital and enterprise, and if England would take pains to cultivate a more intelligent and friendly intercourse and knowledge, so as to direct the stream of British emigration to the British colony rather than to the United States, the results would almost certainly be greatly to the benefit of both England and Canada.

The climate of Canada is very little understood, and is vaguely considered by many people, both in the United States and in England, as being always cold, with specially cold winters. While the

winters are severe the summers are dry and hot, with cool evenings, and the air, particularly in Ontario, is remarkably dry, clear and bracing. Humidity, the bugbear of New York, is unknown. With the steady growth of travel in Canada by tourists, sportsmen and business men from the United States, this is becoming more generally known, but in England it is little understood, as we know by experience. With regard to the development of the resources of the country it appears that, apart from agriculture, the Canadian people have not sufficient confidence in themselves or sufficient speculative energy (meaning legitimate and not wildcat speculation) to rely upon themselves in this direction. This is noticeable in investigating the mineral resources, which have thus far been developed mainly by English and American enterprise, and the owners of many mineral properties look to the United States for people to invest money and for a market for their raw material. As there is an import duty on many such minerals and as the United States has in most cases large resources of its own, there is not a very favorable prospect here for a market for outside ores, unless of exceptional quality, and the Canadian owners do not appear to be willing to invest money in working their properties and establishing smelting and refining works, foundries, etc., even though the country admittedly offers a fair market for certain products. In the case of some of the iron mines, for instance, the main idea of the owners seems to be to ship the ore to consumers in the United States, and, although Canada imports and consumes large quantities of iron and iron manufactures, they hesitate at the idea of themselves working the mines, smelting the ore and manufacturing pig or charcoal iron, etc., for home consumption. There is little doubt that Canada possesses very rich mineral resources, but they are only being developed in a slow and half hearted way as yet.

The route taken from New York was by the New York, New Haven & Hartford R. R. to Springfield, Mass., whence a through Wagner sleeping car is run over the Connecticut River R. R. and Central Vermont R. R., via White River Junction and Newport, Vt., to Sherbrooke, Que., at which place passengers for Quebec by the Quebec Central Ry. change to another Wagner car, the through car to Quebec running over the longer route of the Grand Trunk Ry. At Thetford, Que., are asbestos mines, operated by an English company. It was noted that several of the New York, New Haven & Hartford R. R. regular passenger cars of recent construction have a shallow and almost flat monitor roof, with the lower part of the roof, on each side of the monitor, inclined instead of curved. A decided improvement in baggage racks was noted in the same cars. A strong, rigid brass netting, inclined downward to the side of the car, runs the whole length of each side of the car, being thus more easily accessible and having a much greater capacity than the ordinary brass baskets over alternate seats. These cars were built by Osgood Bradley & Co., of Worcester, Mass. The Wagner cars were new, upholstered in brown plush, and having an interior finish of the dark wood so generally used in sleeping cars and which gives such a gloomy effect to the interior of the cars, although some of the later cars are finished in lighter woods. Many of the Canadian cars, however, are finished in quite light wood and upholstered in soft grey tints, giving a much more pleasing and cheerful appearance than the dark finish of the average American sleeping car. From the railway terminal at Levis, on the south bank of the St. Lawrence, steam ferryboats carry the passengers across to the city of Quebec.

The city is very French in character and population, although the English element is made conspicuous by the uniforms of the military officers, and by the red coats of the infantry and the dark blue uniforms of the cavalry privates who appear on the streets. Great Britain maintains a garrison at Quebec, which is in fact a walled city, the walls and ramparts extending across the high peninsula, between the St. Charles and the St. Lawrence rivers, upon which the city is built. There are three gateways. The fort and citadel are 330 ft. above the water. At the time of our visit the British cruiser "Blake" and gunboat "Magicienne" were anchored off the rocky heights which are surmounted by a fort, giving a naval aspect to the river scene and contributing many sailors to the streets. Many small river steamers, all belching forth dense volumes of smoke, are constantly leaving from and arriving at the landing stage behind Champlain market, and large sailing vessels and ocean steamers stop on their way to and from Montreal. Champlain St. runs along the water front, and under the citadel it crosses the debris of the great rock slide which occurred on Sept. 19, 1889, and caused so much damage (Eng. News, Sept. 28, Oct. 5 and Nov. 2, 1889). On the south side of the road are the ruined houses and the great blocks which wrecked them, while on the north side is the steep slope of the debris formed by the fall of a part of the face of the cliff. The rock is almost black and has a smooth fracture, and besides the blocks of every size there are tons of long, thin, narrow "splinters" of stone. Some large cracks are visible in the face of the cliff, one of which is at the corner of the masonry of Dufferin Terrace, and the end of the terrace has been barricaded and the floor removed to keep people off for fear of accident. The terrace is ¼ mile long, 200 ft. above the water, and commands a fine view of the river. A steep, winding road connects the upper and lower town, and a short inclined plane cable railway, using water ballast for the descending car, runs up to the eastern end of Dufferin Terrace. The lower town has many curious steep, narrow and winding streets. The city is lighted by electricity, the plant for which is situated about eight miles distant, at Montmorency, and is driven by water power, the supply being taken from the Montmorency River above the crest of the noted falls and conveyed in a large iron tubular flume and an open timber box flume to the power station. The city has two horse car lines, one in the upper and one in the lower town. About 20 miles east of Quebec is the village of Ste. Anne de Beaupre, with the church which is noted for the cures effected by a relic of the saint.

From Quebec the route taken was by the Canadian Pacific Ry. to Montreal and Ottawa. Montreal is the capital city of the province of Quebec, and contains the Provincial Parliament buildings. It is a handsome, well built city, and has a large French population. It is the principal port of Canada, and has a number of regular steamship lines to foreign ports. Particulars of the harbor were given in our issue of April 25, and May 2, 1891. Behind the city is Mount Royal, a high, wooded hill, with a winding carriage road and a direct cable incline railway to the summit. The Canadian Pacific Ry. has a terminal station at each end of the city, one of which, the new Windsor St. station, was described and illustrated in our issues of March 3 and 17, 1888. The Grand Trunk Ry. terminal is near the Windsor St. station. In the eastern outskirts of the city the Canadian Pacific Ry. is parallel with but above the wharves along the water front, and cross streets make a sharp turn, run down alongside the railway by a steep grade and pass under the bank. What appears to be part of an elevated railway was noted near the city. Ottawa, Ont., is the seat of the Dominion Government, at the head of which is the Viceroy, representing the Queen. The Parliament buildings are well situated in a park near the edge of a high cliff above the river, and are very handsome and pleasing in appearance. They were designed by Canadian architects and are mainly of native stone of a warm tint, which has a more pleasing effect than granite. The city has an electric railway, new plant for which is now being put in at a new power station, the plant being driven by turbines operated by the water power of the neighboring Chaudiere Falls, which also drives numerous saw mills just below the falls. The electric railway company is negotiating for the extension of its system over the horse car line. The new plant includes a dynamo of 400 HP., one of two built by the Westinghouse Electric & Mfg. Co., of Pittsburg, Pa., which are said to be the largest in America, the other being at Denver, Colo. The plant is being put in by Ahearn & Soper, electrical engineers and supply agents, of Ottawa, and Mr. Ahearn is bringing out a new electric heater which has been in use on the street cars, and is now in use for heating ovens, heating water for houses, etc. On Sept. 17 a dinner was given at the Windsor Hotel, Ottawa, which was cooked entirely by electricity. The American agency for this heater is held by the Railway Equipment Co., of Chicago. At the other end of the town from the falls is the head of the Rideau Canal, with a series of eight or nine locks leading down to the level of the Ottawa River.

Several railway projects were heard of in this neighborhood. The Canadian Pacific Ry. and the Ottawa, Arnprior & Parry Sound Ry. (the latter in the interest of the Canada Atlantic Ry.) have both commenced lines westward with Parry Sound as the objective point, the purpose being to tap the rich lumber districts between the Ottawa River and Georgian Bay. The Central Ontario Ry. and the Coburg, Northumberland & Pacific Ry. also propose to enter the same region from the south. The Ottawa & Gatineau Valley Ry. is still extending its line north up the Gatineau River, and surveys have been made for a cantilever bridge across the Ottawa River in the interests of the Ottawa & Gatineau Valley Ry., the Canada Atlantic Ry. and the Pontiac & Pacific Junction Ry., but this is not likely to be built for some time, and meanwhile the Ottawa & Gatineau Valley Ry. uses the Canadian Pacific Ry. bridge and station at Ottawa. The trip down the Ottawa River by the steamers of the Ottawa River Navigation Co. from Ottawa to Montreal, 130 miles, is very interesting. The "Empress" runs from Ottawa to Grenville, where passengers land for 13 miles of railway travel over the antiquated Carillon & Grenville Ry., with a dilapidated track laid with old English rails of bridge section, and having an engine which was built at Birkenhead, England, about 30 years ago. These 13 miles of railway are the last remaining of the old Canadian broad gage of 5 ft. 6 ins. (Eng. News, Aug. 4, 1892), and will probably be changed to standard gage before long, as a new line from Montreal is being built to a connection with this road at St. Andrews. The freight steamers pass through a canal and locks between Grenville and Carillon to avoid the rapids. From Carillon the steamer "Sovereign" runs to Montreal. At Ste. Anne, near the mouth of the river, the steamer passes through a lock and under the bridges of the Canadian Pacific Ry. and the Grand Trunk Ry. The former is a modern double track iron bridge on masonry piers, with eight deck plate girder spans at the west end, two deck lattice spans, one truss channel span and three through lattice spans at the east end. The latter is single track, with a tubular channel span, plate girder deck spans at the west and three through plate girder spans at the east end, crossing the locks. The masonry piers are being widened for a double track structure. The steamer passes under the Lachine bridge of the Canada Atlantic Ry. (Eng. News, Oct. 1, 8 and 15, 1887), the western timber trestle approach of which is being filled in for a solid embankment. Below the bridge the steamer runs the Lachine rapids, an interesting ride which is taken by many Montreal people and tourists who come out on an afternoon train to Lachine in time to catch this steamer. Before reaching the landing stage the steamer passes under the great Victoria tubular bridge which was designed by Robert Stephenson for the Grand Trunk Ry. to give through railway communication, and opened in 1860. The bridge is single track, and consists of 25 spans carried on heavy masonry piers. The center span is 330 ft. and the others are 242 ft., the total length of the bridge being 6,650 ft. The headway is 36 ft. at the end spans and 60 ft. at the center span, the railway having a grade of 0.77% from each end of the bridge.

From Montreal the Grand Trunk Ry. was traveled over westward to Trenton, where a stop was made for a run over the Central Ontario Ry. to the ore shipping dock on Weller's Bay and north to the iron mines at Coe Hill, of which we shall have more to say in a later issue. There are some gold mines along this line, some of which are in operation and are said to pay well. The Grand Trunk Ry. was then followed from Trenton to Toronto, and then north over the Midland Division to the city of Midland, which is situated at the south end of Georgian Bay and has a large grain elevator. From this point the steamer "Manitou" of the North Shore Navigation Co. was taken to Parry Sound, 60 miles north; a very pleasant trip through island scenery rivaling that of the Thousand Islands of the St. Lawrence. At Parry Sound the principal business is in lumber, but the sawdust from the saw mills is not dumped into

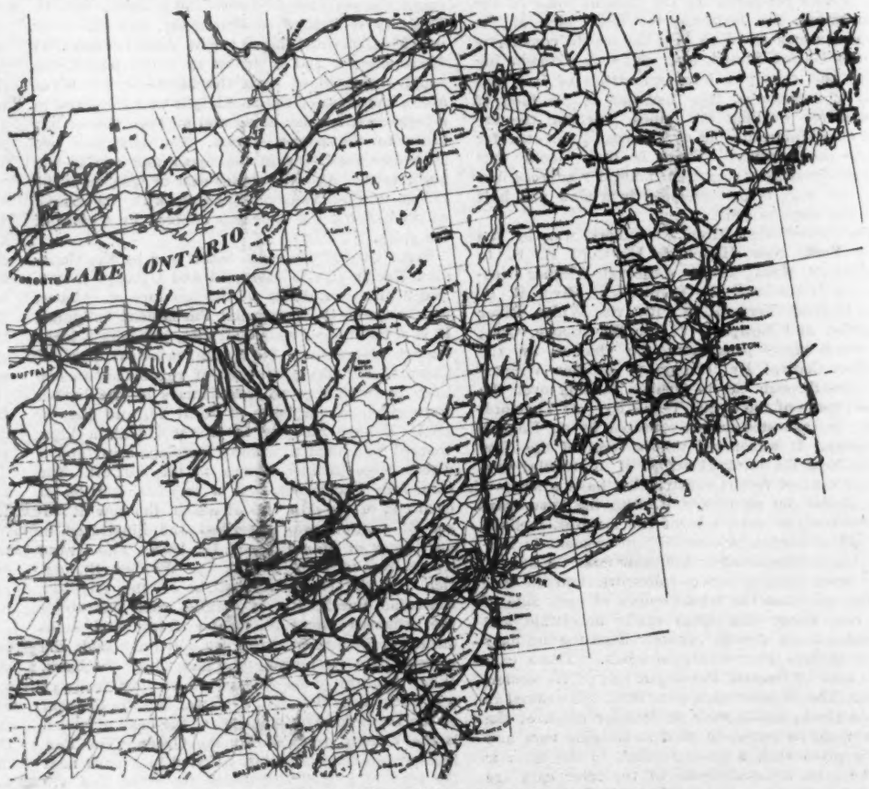
water as at Ottawa (where the river is almost choked with the accumulations of years, said to be 40 ft. deep in places), but is burned in tall iron furnaces, like blast furnaces, covered with a wire hood or bonnet as a spark arrester. Water-works are under construction at this place. The supply will be taken from the Sound by an intake pipe and pumped to a steel tank on a masonry tower erected on a hill about 100 ft. above the water. On this hill is the Belvidere Hotel. The pumping station is of brick and is situated on the shore. Cast iron mains are being laid, and the trenching involves much rock work. From Parry Sound there is a stage road to Port Cockburn (at the head of Lake Joseph), 18 miles, and Rosseau (at the head of Lake Rosseau) 24 miles west. These lakes, with Muskoka Lake at their southern end, are the three largest lakes of the Muskoka district. The road is a government road, used for the mails, and is alternately in heavy soil and mud, and on the bare rock. Holes are repaired by corduroy work, and the bottoms of steep grades are eased off by banks of logs covered with earth. Contracts for repairs are let to farmers along the road. In this part of Canada most of the best timber has been cut and large tracts burned over, but there is still a large quantity of timber remaining. From Port Cockburn the little screw steamer "Muskoka," of the Muskoka & Georgian Bay Navigation Co., was taken south, passing through the beautiful scenery for which this district is noted, as well as for the hunting and fishing which it affords. The steamer traverses lakes Joseph and Muskoka, which are connected by a lock at Beaumaris, and lands its passengers at Muskoka Wharf, near Gravenhurst, where a fast train is in waiting to carry them to Toronto.

Toronto is a large and thriving city, with a brisk businesslike air about it, and a strong tendency to be abreast of the times. It is clean and cheerful looking, and has many fine buildings. In fact it is surprising to see so many large new office buildings, but we were informed that the offices are in demand all the time. Near the city are the new Parliament Buildings of the Ontario provincial government, but they are not yet completed. It is unfortunate that the fine water front is so entirely blocked by railway tracks, wharves and sheds, and whether the alterations consequent upon the construction of the new union station will improve the present condition remains to be seen. The plans for this station have been approved by the Grand Trunk Ry. and the Canadian Pacific Ry., and it is expected that work will be commenced in the spring. A report on the water front and railway terminal question was published in our issues of Jan. 4 and 11, 1890. There is a large growth of suburban districts, and sewerage systems are being built at North Toronto and Toronto Junction, for both of which Mr. Willis Chipman, of Toronto, is the engineer. The new electric railway is in operation, and although many accidents occurred during the first few weeks, the operation is now more successful. The track is laid with girder rails and the space between the rails paved with asphalt. The overhead trolley wire system is used, and there is some sparking at the trolley, which appears to frighten horses more than the movement of the train. The motor cars are closed, and haul one or two trail cars. Round cedar block paving is used in most of the business streets, and has the usual uneven and unattractive appearance of this style of pavement. A belt line of railway has recently been opened by the Grand Trunk Ry.

The annual Toronto Fair, which is held on permanent fair grounds, was open at the time of our visit. Its main features are agricultural, there being large exhibits of threshing and other machinery, wire fence machines, portable engines, farming implements, fences and gates, wind pumps, etc., as well as horses, dogs, cattle, poultry, and samples of farm produce, including samples of corn, etc., grown at the Agricultural College. One building was devoted to carriages, and the Canadian Pacific Ry. had a building in which were displayed cereals grown, minerals obtained, etc., at various points along its western lines. Among exhibits of technical interest were samples of native cement manufactured by the Owen Sound Portland Cement Co., of Owen Sound, Ont., which cement has been extensively used on sewer, street and bridge work in Toronto, and on the Sault Ste. Marie canal, etc. The Finch Wood Preservative Co., of Toronto, exhibited specimens of treated an untreated paving blocks of tamarack and cedar, as used in Toronto, but no particulars were given of the composition of the preservative.

The southern part of Ontario is a rich agricultural country, and, in the southwestern part especially, large quantities of fruit are grown, both tree fruit and berries. From Toronto to Kingston there is a broad, well kept turnpike road, which is a mail road. The contract for maintenance is let by the government, and the contractor collects the tolls. There are numerous country roads in the farming districts, following the section or concession lines, but they are generally very poorly kept, dusty in summer and sometimes almost impassable from mud in the winter. They are repaired by dumping gravel along the middle, or by throwing up the turf and dirt removed from the ditches. In soft places one or more logs are laid across the road and partly covered with gravel. The culverts which cover the ditches under the ends of cross roads are of planks, not unfrequently loose. The small bridges over creeks and streams are generally rough structures of planks and squared timbers, and very often there are nasty holes between the gravel roadway and the bridge floor planking. The people of each section elect a "pathmaster" from among their number each year, and he has charge of the repair and maintenance of the roads. In some places young trees are planted along the side of the road, for which, in some counties, the County Council pays the farmer who plants them 25 cts. for each tree. In threshing time the farmer hires a machine and engine from a neighbor or from a man who makes a business of threshing, with three men to attend to them, and each neighbor furnishes free one man's labor for the work on the stack and in the barn. Threshing day is a day of feasting, a big dinner being got up for the large number of men employed. Some of the machines are drawn by traction engines, the same engine driving the thresher, and these are preferred by the farmers, as they do not have to send their men and teams to haul the engine and thresher from the place where last at work.

From Toronto, through sleeping cars, leaving at 4:55 p. m., are run to New York by the New York, Lake Erie & Western R. R. (Pullman car) and the New York, West Shore & Buffalo R. R (Wagner car), by way of Hamilton, Niagara Falls and Buffalo. At Hamilton a dining car is attached to the train, and meals are served on the European plan, but as there are only two waiters the service is rather slow. This car is run as far as Suspension Bridge. At this station the United States customs officers make their inspection of incoming baggage, and during the recent cholera scare a doctor went through each train, looking casually at the passengers and inquiring of the conductor if he had any sick persons on board. From Buffalo to New York the Erie R. R. has a double track laid with 80-lb. rails and plenty of ties on good stone ballast, and equipped with the block signal system. The rails are laid to break joint, and the joints are supported on three ties and spliced with 40-in. angle bars and six bolts. The signal posts are painted a dark ochre, which diminishes the sharpness and distinctness of the red or green blades. With a white post the blades show very much better. At Hornellsville the Toronto car is attached to the rear of the Atlantic express, from Chicago, and at Port Jervis a dining car is put on, about 9:13 a. m., on which a uniform charge of $1 per meal is made. The train was hauled by a ten-wheel Baldwin engine and consisted of two mail cars, a baggage car, two passenger cars, a dining car and three sleeping cars. It was blocked by signals two or three times near the marshes west of the Bergen tunnel, but arrived at the Jersey City terminal station (Eng. News, May 29, 1886), only a few minutes late.



MAP OF THE PHILADELPHIA & READING R. R. SYSTEM.
(Indicated by Heavy Black Lines.)

THE PHILADELPHIA & READING RAILROAD SYSTEM.

The recent acquisition of the Boston & Maine R. R. system brings the mileage of railway line now controlled by the Philadelphia & Reading interests well up toward that included in any of the larger railway systems of the United States. To define the term railway system is somewhat difficult, for the bond which causes two railway corporations to work together in more or less harmony is of many sorts and shades of strength.

For the present purpose, however, we include in "railway system" all lines owned, leased, or controlled in the same interest, meaning by the latter term such control by ownership or guarantee of securities as will cause the controlled line to be operated in harmony with the main company against outside competitors. This definition of the term, we think, may be regarded as a fair one.

Upon the above basis the total mileage of the Philadelphia & Reading R. R. system is 5,644 miles, made up as follows:

	Miles of railway.	Miles of track.
Philadelphia & Reading	1,173	2,400
Central R. R. of New Jersey	662	1,370
Lehigh Valley	928	2,174
Delaware, Lackawanna & Western	899	2,035
Poughkeepsie Bridge system:		
Bridge	3.5	3.5
Central New England & Western	164	198
Pennsylvania, Poughkeepsie & Boston	96	108
New York & New England	508	802
Boston & Maine	1,210	1,936
Total	*5,644	*11,087

* These figures are taken from the last issue of "Poor's Manual of Railroads," no attempt being made to include the increases in the mileage of line and track made during the present year.

An examination of the accompanying map, upon which these several lines are shown in their correct geographical position, will show the extent of territory embraced in the system. It will be seen that it consists of two tolerably compact homogeneous systems of lines lying on either side of the Hudson River where they connect by the single tracks of the Pennsylvania, Poughkeepsie & Boston and the Central New England & Western railroad companies at the Poughkeepsie Bridge. East of the river its lines run as far east as Boston, Mass., and Portland, Me., and as far north as Sherbrooke, P. Q., and Maquam Bay, Vt. On the west side of the river the system extends south to Philadelphia and southern New Jersey, and north and west to the lake ports of Oswego, Rochester and Buffalo, N. Y. These two divisions together thus reach through this network of lines a large proportion of the principal commercial and manufacturing cities and seaports of the New England and Eastern Middle states, and penetrate the heart of the Schuylkill and Mahanoy coal fields of Pennsylvania. We have considered some of the possibilities of these conditions in another column and shall not further discuss them here.

The history of the growth of this great system from half a score of small systems of railways is embraced in the short period of ten months. At the beginning of the year 1892 the mileage of the Philadelphia & Reading R. R., with the lines leased and controlled by it, was 1,173 miles. In February, 1892, the Lehigh Valley R. R. and the Central R. R. of New Jersey, with a mileage of 928 miles and 662 miles of line, respectively, were leased for 999 years, and, during the same month, a controlling interest in the Delaware, Lackawanna & Western R. R., operating 899 miles of line, was acquired by parties in the Reading interest. It should be noted, here, however, that nominally the lease of the Central R. R. of New Jersey has been annulled by the New Jersey State Legislature, but, as the same capitalists are interested in both lines now, as before, this action is likely to have little effect upon their actual operation as parts of one system. Since February a controlling interest in the Poughkeepsie Bridge system and the New York & New England and Boston & Maine lines has been secured, adding nearly two thousand miles more to the system and bringing its total mileage up to 5,644 miles as before stated. In this connection it is to be noted that a very large proportion of the total system is double tracked, the total miles of track being nearly twice as many as the total miles of line. Most of this is contained on the lines in New York, New Jersey and Pennsylvania.

The following table shows the comparative length of line operated by the Philadelphia & Reading system and that of some of the other larger systems in the country:

	Miles.
Vanderbilt lines, including Chicago & Northwestern	15,318
Atchison, Topeka & Santa Fe	5,521
Gould Lines	8,935
Pennsylvania	7,940
Union Pacific	7,642
Southern Pacific	6,461
Philadelphia & Reading	5,644
Northern Pacific	4,348

It will be seen from these figures that the Philadelphia & Reading stands considerably below several of the other great systems of the country. In the matter of mileage of track and gross earnings, however, it makes a far better showing, being exceeded, we think, by only the Vanderbilt and Pennsylvania systems. A rough summary of the earnings from operations of the several lines included, shows gross earnings amounting to about $99,000,000 and net earnings amounting to about $36,800,000. The gross earnings of the Pennsylvania system in 1891, were $134,254,613 and the net earnings, $42,434,953. Of course the figures of earnings given for the Reading system were those of several small unconnected and, in some cases, competing lines. To what extent they can be increased by all of these lines working together to maintain rates and by the increase in economy of operation, is entirely a matter of speculation. Some progress in this direction can naturally be expected. The expansion of population and the growth of manufacturing activity will demand a steady increase in the consumption of coal from year to year. In addition, if this coal can be supplied cheap enough no doubt room can be found for additional quantities in any event. Any very large increase, especially in the tonnage shipped to New England, will, however, require a considerable increase in the present facilities for its transportation.

THE ROCK-DRILL APPLIED TO OPENING THE TAPPING-HOLE OF A BLAST-FURNACE.*

Devices for saving labor in immediate connection with the operation of the iron blast furnace have received comparatively little attention. Machines for hoisting and blowing, always employed in some form, have been improved; but charging, tapping, casting and handling the pig iron in the beds are still performed chiefly by manual labor. At almost all furnaces, filling is done with the hand-barrow of 25 years ago; and it is only recently that, here and there, chills instead of the usual sand-beds have been employed in the cast-house to lessen the labor of handling the pig, as well as to secure its greater purity.

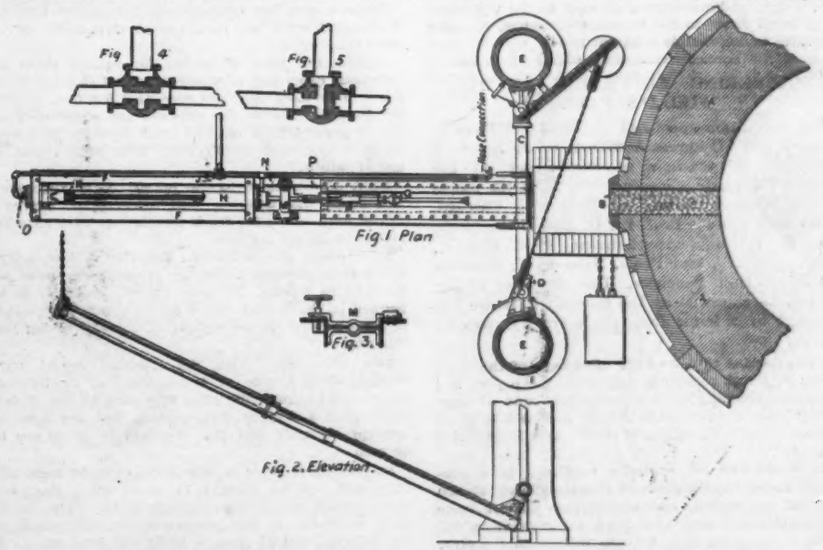
The manual labor of opening and closing the tapping hole has been, so far as I know, rather increased than diminished. The enlarged hearths and greater capacity of the modern furnace render it more difficult to "keep the tap-hole back," as furnace-men say. In the old-fashioned smaller furnaces, the slacking of the blast-pressure, and the introduction of a single ball of clay, involving (for closed fronts) an average stoppage of not more than three minutes, sufficed for plugging the hole, and opening it was correspondingly easy. No care was taken in the selection of material for the purpose, ordinary brick clay being found sufficiently refractory. At present, fire-clay, mixed with graphite, is sometimes used, or the material of old black-lead crucibles is rammed in with balls of clay; and, instead of one ball, a wheel-barrow load is often required. Indeed, in "putting in a new hole," three or four barrows of clay-balls, with a barrow of fire-brick, may be required. To make a large hearth safe against "break-outs," the clay stopping should be "kept back" 3 ft. from the outside of the tap-hole.

To open at casting-time one of these deeply and thoroughly stopped iron notches requires the labor of eight or ten men, drilling with a heavy bar for from 10 to 30 minutes, sometimes even 60 minutes, according to the condition of the furnace. This work is exhausting; and it is usual to call the men from the stock-house to assist in opening the hole, as well as in special work in the cast-house, while the iron is running. Probably the main reason for the general absence of attempts to diminish the manual labor at the tapping-hole has been the presence of a large number of "fillers," available at casting-time for work before the furnace. But, on the other hand, this extra work imposed on the fillers has stood in the way of a reduction of their number.

At the blast furnaces of the Maryland Steel Co., the adoption of a new system of furnace-charging rendered it practicable to reduce the labor required for filling; and the contemplated delivery of the molten iron direct to the Bessemer converter would reduce the labor needed in connection with casting. But to secure the full advantage of both these improvements, it was necessary to do away with the requirement of many workmen for hand-drilling at the furnace-front. This consideration led to experiments with the percussion rock drill as a tap-hole opener.

The first trial was made in the autumn of 1890. The drill employed was the Little Giant, No. 4, of the Rand Drill Co., a somewhat heavier machine than is usually adopted for work in rock. It was mounted on the regular swivel-base, clamped to a horizontal bar, which was swung from a column as a crane. The difficulties with this mounting were the short feed, and the long time required to withdraw the bit, after the hole had been drilled. We modified this arrangement by increasing the radius of the crane on which the drill was clamped, and by simplifying the fastening, so as to permit a quicker removal. The result, however, was still unsatisfactory. We burned too many bits.

The present method of mounting, described below, has been entirely successful. The feed is long enough to enable the bit to penetrate through the clay-stopping in all cases; and the bit can be retired instantly without danger to it. In case of a very "hard" hole, the withdrawal may be made frequently, and the bit may be cooled in water without greater loss of time than in hand-drilling.



ROCK DR'LL APPLIED TO OPENING TAPPING-HOLE OF BLAST FURNACE.

The feeding is accomplished by a cylinder containing a piston and rod attached to the drill where the usual feed-screw is fastened. The piston rod is hollow, and serves both to feed or withdraw the drill and as a channel conveying steam to the operating cylinder.

In Fig. 1, A is the section of a part of the hearth of the blast furnace; B, the tap-hole; and C, a cross-bar arranged with guides to slide on vertical bars attached to the columns, E.; F is the frame consisting of two parallel angle-bars attached to the horizontal cross-bar, C. G is the drilling-machine which travels in suitable guides bolted to the angle-iron frame. H is the feed-cylinder made of wrought iron pipe, bored out, or of brass pipe, which does not require boring. I is the supply pipe, which is connected with the pipe at

* Abstract of a paper by Mr. David Baker, Maryland Steel Co., Sparrow's Point, Md., presented at the Schuylkill Valley meeting of the American Institute of Mining Engineers at Reading, Pa., October, 1892.

the column by hose or by wrought iron pipe provided with swivel-joints. One branch of the supply pipe, I, connects with the front head of the cylinder at N; the other with the back at O. In the branch leading to the back of the cylinder is placed a three-way cock, J. K is the piston of the feed cylinder, axially cored to allow steam to pass from the front end of the cylinder to the drilling machine. L is the hollow piston rod connecting with the valve-chest of the drill by means of a steel tee and pipe, P. The friction-clamp, M, shown in detail in Fig. 3, grips the piston rod and thus may be used to regulate feed. The machine may be counterbalanced by weights so as to be easily pushed up by hand when not in use; or the chains may be attached to the piston of a hydraulic or steam cylinder.

While in use the frame stands as shown in the elevation, the angle depending on the condition of the hearth of the blast furnace. The operation of tap-hole drilling is as follows: When it is time to cast, the frame is lowered to the right position; steam is admitted; and the three-way cock is turned, as shown in Fig. 4. The effective pressure in the rear of the piston being greater than that in the front, the drill is fed up to the work, but is prevented from going too far by the clamp, M. A cock in the valve-chest of the drill is now turned, and the drilling is begun. The feed may be controlled by the friction-clamp.

As soon as the melted iron is reached, the friction-clamp is loosened and the three-way cock is turned into the position as shown in Fig. 5, thus allowing the steam to exhaust from the rear end of the feed-cylinder. This removes the bit from the tap-hole at once, and the tap-hole being open, the machine is pushed up about ten feet out of the way. In practice, we have found it necessary to put a spring in the rear end of the feed-cylinder to take the shock from the head in case the piston should be allowed to go back so fast as to become uncontrollable.

The advantages of the power-drill over the old hand-drill are: 1. It is much quicker and cuts a better hole: that is, more nearly a true circle. We have found that this tends to make the tapping-hole stand longer against cutting-out by the hot iron and cinder. 2. The percussion-drill itself is useful for other purposes. Even when the furnace is out of blast it can be mounted on a tripod and employed, to the saving of much time, in drilling the salamander. 3. The most important saving, however, is the labor before the furnace—the helpers. Since the adoption of the steam-drill we have been able to save one man at each turn, or two men a day; and we expect, as soon as the pig metal is all taken direct to the Bessemer converter, to make a greater saving than is apparent now.

ENGINEERING EDUCATION AT THE WORLD'S FAIR.

The committee appointed by President Bonney, of the World's Congress Auxiliary, to arrange for a conference of teachers of engineering at the World's Fair, held a meeting Oct. 22 at the rooms of the Western Society of Engineers, Chicago. There were present Prof. Ira O. Baker, chairman; Pres. H. T. Eddy, vice-chairman; Prof. Wm. R. Hoag, secretary, and Profs. Samuel W. Stratton and Storm Bull, members. The substance of the conclusions approved by the committee, as we are informed by a letter from the secretary, was as follows:

It was decided to devote the afternoons of the week ending July and beginning August to the papers and discussions touching on the pedagogical side of engineering, since the forenoons of this week will be given to carrying out the program of the General Engineering Congress.

The conference on educating engineers is a subdivision under the Congress of Engineers, and, though electrical engineering and architecture do not come technically under the same head, the committee, believing it would be their wish to unite with the civil, mechanical and mining engineers in this matter, outlined a program in which all should be equally represented.

It was the judgment of the committee that a part of the meetings should be devoted to papers on subjects of common interest to all the engineering divisions, while the rest would be given to sectional meetings in which one or more branches of engineering would take part, according to the nature of the subjects under discussion.

A partial list of desirable subjects for papers was made out, and as far as possible, professors indicated from whom papers would be asked.

The small amount of time for these papers, and the desirability of having the discussions following very free and full, suggest a brief, clear statement of the conditions and bearings of the subject rather than an exhaustive treatment.

The aim of the committee was to distribute the papers on subjects of common interest among the five professions and among the institutions giving engineering courses as equally as possible.

The small number of such papers and the large number of schools brings the burden of the papers on only an occasional institution. It is, however, the desire of the committee to enlist the cooperation of every teacher and professor in engineering as to suggestions for papers and subjects for discussion.

Every teacher or practicing engineer interested in the educational side of engineering in this country, or in any country, is invited to be present at the meetings, and to take part in the discussions.

An outline of the conference will be found in the circular of the Engineering Congress, which is to appear soon.

ENGINEERING NEWS FROM MICHIGAN.

We have received from Mr. C. E. Fowler, of Youngstown, O., the following brief notice of some features of engineering interest seen on a recent journey through Michigan.

The electric car systems are now in operation in all parts of Detroit, and seem to run with very little trouble of any sort. The horse car lines out Woodward Ave. are soon to be changed to electric, the track is now being relaid with heavy girder rails, while the street is being paved with asphalt.

When the writer was in Detroit some six years ago, nearly all the streets were paved with wood blocks, but now these are being replaced by some more durable material, as the growth of the city demands it.

Leaving the city by the Michigan Central R. R., I was surprised to see a very heavy elevated railway structure, which is said to be about a mile in length and built for the Michigan Central R. R. by the Detroit Bridge Co.

At the Detroit Bridge Co.'s works there were a great many short girder spans in sight, ready for shipment.

A HIGHWAY BRIDGE OF ROUND TIMBERS.

Many of them were for the Lake Shore & Michigan Southern Ry., we were informed, this road having arranged to change many existing light trusses to shorter spans of girders.

Saginaw and Bay City are the first places that tell forcibly of what has been the chief industry of the state—lumbering.

Besides the piles of lumber for market there are enormous quantities of waste-slabs and chunks, which seem to be more than are ever used for fuel, as they are used for fills on the railways and elsewhere; one fill of great length on the Flint & Pere Marquette R. R. being entirely of these, with a thin coat of gravel ballast.

Much of the waste is also burned up in huge sheet iron stacks, not unlike a blast furnace, and having a cap of wire screen for spark arrester, as have all other stacks about the mills.

From Alger, by the Detroit, Bay City & Alpena Ry., one travels through a country stripped of timber all the way to Alpena. No more forcible lesson is to be learned in the United States of the almost entire lack of some needful timber legislation, than by taking just this trip.

Mile after mile, with the country covered with stumps, dead trunks of trees, standing or leaning, charred and burnt; mile after mile with no live timber other than a scrubby undergrowth, and the land so swampy or sandy that few clearings or farms are to be seen.

An occasional grove of slim pines is to be seen, but they will not be allowed to stand after they are large enough to cut for telegraph poles. There is, in fact, no timber of any consequence in easy reach of the railway, and all that is being cut from far back is hauled in to the main line or to some of the branches and hauled by log trains to the mills on the coast. These log trains, as seen from the car window, are made of two ordinary car trucks close together, and having bolsters only; these are coupled by long leading timbers, to allow plenty of swing on curves.

At Au Sable one can see out on Lake Huron, and here are loaded great quantities of timber. The Au Sable & Northwestern, a narrow gage road, meets the Alpena road, and penetrates quite a distance inland for timber.

Along the line of the road was noticed a highway bridge of ingenious construction, which has not been placed on record; it has a span of about 80 ft., and is made of round timbers, the piers being cribs and the flooring of slabs, as shown in the accompanying sketch.

Alpena boasts of a drawbridge which is conspicuous only for being fully light enough. The railway crosses a stream on a bridge of four or five plate girder spans, which look strangely out of place on timber foundations—timber cribs filled with stone have been sunk, and on these are crossed timbers built up to carry the girders.

A PERFECT OVERHEAD CONSTRUCTION FOR ELECTRIC RAILWAYS.*

Iron or steel poles have proved to be the most desirable. The lower section should be at least 7 ins. in diameter, and the other two sections 6 ins. and 5 ins., respectively. The poles should be 32 ft. long, set in concrete, and at least 6 ft. in the ground, and should not be more than 125 ft. apart. The top of the pole should have about 2% of rake away from the curb, and should be fitted with a suitable pole clamp, so that the span wire can be easily adjusted to the required height, which should be 22 ft. above the track. On top of the pole should be a malleable iron cross-arm to carry the feeder wires, and guard wire spans. This cross-arm should be insulated from the pole by means of a wooden plug inserted in the top of the pole. The insertion of the joints of the pole should be at least 18 ins., and the joints should be made solid throughout their entire length by means of shims, or other contrivances. If these joints are not properly made, the poles will not stand the strain. For curves, or extra strain, there should be larger poles of the same make.

Span-wires should be of No. 4 "B. W. G." silicon bronze wire, and should be fastened to pole clamps by means of insulated turn-buckles. Great care should be taken in insulating these turn-buckles from the poles.

All well-built lines should be sectional, and the trolley-wire should not be of too great a size, as it would then call for clumsy supports. As it is not the main current wire, it can be of smaller size. I would therefore recommend No. 4 B. W. G. silicon bronze wire, which affords sufficient carrying capacity, and has great strength and durability. Sections should not be of a greater length than two miles, and should be separated by trolley-breakers. In cities and villages, where there is great liability of fires, it would be advisable to put trolley-breakers at shorter intervals. Trolley-wire hangers and pull-off brackets should be of the lightest make possible with the required strength, and should have the very best insulation.

As it is important to have as small a number of joints as possible in the trolley-wire, it should be put up in mile lengths, and twisted splice joints should be made, and brass cone-shaped tubes slipped over the wire before the splice is made. After completing the splice, the larger ends of the tubes should be brought together over the splice and a little solder dropped through a small hole made in the tubes for that purpose, in order to keep the joint in place. Overhead switches, or switch-pans, should be avoided, if possible, as they become a source of great annoyance. I would strongly recommend a double trolley wire for a single track road. Great care should be taken in erecting the guard-wire spans. They should be properly insulated from the cross-arm by means of a strain insulator, or something equally as good, and should be of at least No. 6 best galvanized iron wire. There should be two guard wires over each trolley wire at least 3 ft. apart and 4 ft. above the trolley wire. The guard wire must be well insulated from the guard spans; in case of other wires falling, this would be of great importance. Pull-off and anchor guy-wires, or other wires for the same purpose, must be of the very best material, and of at least No. 8 galvanized iron wire.

Feed-in taps must not be more than five poles apart and should take the place of the trolley span-wire at that point. They should be of at least No. 0 insulated wire. The trolley wire being sectional, it is necessary to run a feeder-wire to each section. I would recommend that the feeder-wire be at least 30% larger than is ordinarily used. It will be found that this is money well invested. The insulation on the feeder-wire should be the best that can be procured, and I would advise using locust or iron pins with mica insulators or something equally as good, for the purpose of fastening the feeder-wire to each pole, and great care must be taken to protect it from trees and other obstructions.

A cut-out box should be located on the pole at each trolley-breaker, and should not carry a fuse. It should have the same wire running through it as there is on the outside. The fuses should be at the station, with ampere-meter and cut-out switch for each section; then, in case of trouble on any section, the location can be easily seen, and that section cut out if necessary until repaired. Lightning arresters are of great importance on the line, and I would strongly recommend using them at least every 1,000 ft. They can easily be at-

* Slightly condensed from a paper read by Mr. Chas. H. Smith at the Cleveland meeting of the American Street Railway Association.

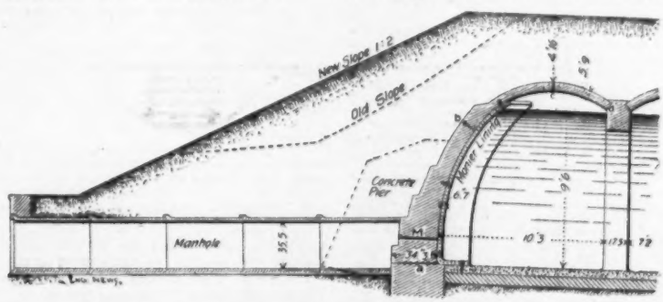
tached to the poles, and can be protected by means of a box.

In conclusion, I would say that no matter what expense is incurred for material, or what care used in conducting, a good line cannot be insured without a thorough daily inspection.

REPAIRING A RESERVOIR WALL, REGENSBURG, GERMANY.

The following method of repairing a rupture in the walls of a covered reservoir at Regensburg, Germany, is taken from the "Journal fuer Gasbeleuchtung und Wasserversorgung": The reservoir was square in plan with a capacity of 872,500 gallons. When emptied for the last annual cleaning it was found that the south wall showed two horizontal cracks about 125 ft. long; one at the foot of the wall, at "a," the other at the crown of the arch, at "c." A trench dug through the earth backing revealed a third fissure on the haunch, at "b." This last was open on the outside, while the other two cracks opened inward, toward the basin. It is probable that there was a fourth crack at the springing plane "d."

The cause given for this settlement was the insufficient covering of the arch with earth. During the extremely cold winter of 1890-91 the ground froze to a depth of nearly 4 ft., and the top layers of the slope containing much loam, bulged up and still further decreased the weight on the haunch of the arch. The outward pressure of the water in the reservoir resulted in the formation of the cracks, though no leakage was then observed.



REPAIRS OF A RESERVOIR WALL, REGENSBURG, GERMANY.

Repairs were commenced by building fifteen buttresses of well rammed concrete against the outside of the damaged wall, as shown. An additional thickness of 3.28 ft. of earth was also added to the embankment. The cracks were then cleaned and filled with cement mortar. The original wall was rubble masonry, and to strengthen it a 6.7 in. lining of the Monier type (a metal webbing and cement) was applied to the inside and fastened as shown. The wires used in this lining were 3-16 to 9-32 in. diameter and the meshes were 6.7 ins. square. A hole, M, was drilled through the masonry wall to the lining and a manhole about 2×3 ft. was laid through the embankment to the outlet of the hole, so that any leak between wall and lining could be detected. The repairs cost about $2,000, and so far no leakage is evident.

FRAUDS IN THE COMSTOCK MINE'S MANAGEMENT.

The returns from the Consolidated California & Virginia mine for the month of August indicate that ore worth $23.91 per ton at the mine cannot be worked except at a loss to the owners of the shares. The 4,350 tons of ore extracted from that mine during the month mentioned was worth, according to car-sample assays, $23.91 per ton, or a total of $112,708. This ore netted the company, after deducting milling and transportation charges, $35,480, or about $8.15 per ton. It seems strange that while $3 free-milling gold rock can be made to pay elsewhere, $23.91 rock, going more than half gold, cannot be made to pay on the Comstock. Of course there is an explanation for this, and it may be divided under several heads:

1. The fact that the mills make such low returns. Formerly mills bought Comstock ores outright, paying the companies 65% of the wagon or car-sample assay, and got their pay out of the 35% they retained. In the Consolidated California & Virginia working for August, the mill company returned 64.63% of the car-sample assay and charged $5 per ton for crushing, so the company is out $21,750, and the mill company got the 35% residue besides.

2. The cost of transportation is also an outrageous item, $1 per ton being charged for transporting the ore about 20 miles. When it is realized that the mines of the Comstock and the citizens of Nevada built the Virginia & Truckee R. R. and presented it to the gentlemen of porcine inclinations who now own it, the extent of the extortion can be appreciated.

The owners of this road can have very little real interest in the state or the mines when, in this time of depression and assessments on the Comstock, they refuse to reduce their bonanza-time scale of charge.

3. Another outrageous charge is that made for water. The company which supplies the water for the mines and mills on the Comstock is owned by the same set of men who have made a success out of milling the ore from mines, while the mines themselves have had to be kept running by assessments on stockholders. The rules of this water company are peculiar, and, one might say, slightly arbitrary. If a mine or mill shuts down, the employees of the water company go right along charging up the water, and when the company concludes to start again the water company informs them that they cannot use the water until the back charges are paid up. If the mining company demurs, they are informed that if they do not like it, they can get their water elsewhere. As there is no other water to be had the decision can be guessed.

4. Then there is the nice little charge for wood. At Empire City it costs $5.50 a cord. Empire City is 20 miles away from Virginia City and Gold Hill, and when this $5.50 wood gets to those places the price is $9.00 per cord.

This advance of $3.50 per cord is due to the charges of this same Virginia & Truckee R. R. The timbers for the mines are all supplied on the same scale of overcharge. As these timbers are also furnished by this same ring, they do not economize on the charges, but take "all the traffic will bear," and the poor devils that own the stock can continue to pay assessments. The history of the balance of the material furnished the mines is the same one of plunder, overcharge and mismanagement. Superintendents who are paid fancy salaries spend a good part of their time in San Francisco, or in junketing trips around the country, relying on the influence of their mill-ring relations to keep them in place. It is a "go as you please" race as long as fools can be found to pay assessments. Under such circumstances, the man who buys Comstock shares is apt to commit financial suicide. If an ore body is found, the mill owners get the best part of it or eat it up in charges and poor work, and the shareholder is assessed to take it out. If they do not find an ore body, they assess him to do the prospecting work. Probably the best way to remedy these various evils is for people to refrain from buying the shares in Comstock mines while under the present system of management. If they keep their money in their own pockets, they at least know where it is. The mines could be made to pay very well if conducted by proper methods, but the existing conditions are very discouraging to all persons interested in the advancement of legitimate mining.—"Mining and Scientific Press."

Armor plate to the amount of about 7,000 tons is soon to be advertised for by the Ordnance Bureau of the Navy Department. This is for the two warships authorized by the last Congress and to finish battleships and other armored vessels now building. Nickel steel treated by the Harvey process will probably constitute the bulk of the order. The thickest plate to be called for will be 14 ins., or 4 ins. less than that designed for the side armor of the three battleships now building, the difference being due to the increase in the resistance quality of a Harvey plate over untreated nickel-steel.

An automatic railway ticket-selling machine is in use by the Berlin City & District Railway. By putting a 10-pfennig piece (2½ cts.) into the slot a ticket is secured. It has been in use some time, and the result is stated to be very satisfactory to the railway company and to the public. Similar machines might be worth trying on the Manhattan elevated railway system on "rush" days.

The work of testing the formation through which the proposed Prince Edward Island tunnel would pass, is being carried on by the Electric Mining Co., of Ottawa. Test holes are drilled about 2,000 ft. apart, the depth of the water varying from 60 to 100 ft. So far, the material found is sandstone interstratified with clay.

The Inman Line steamers, the "City of Paris" and the "City of New York," will fly the American flag after March next. They will sail from Southampton, England. The two big ships of this line will be admitted to American registry while they are in the Liverpool dry-dock.

A topographical survey of California is to be asked for from the next State Legislature—to cost the state $25,000 annually, and to be finished in ten years. It would be made by the state in conjunction with the U. S. Geological Survey. Maj. Powell, in addressing a meeting of citizens called for this purpose, said that the valley, foothill and lower mountain areas of the state could be surveyed for mapping on a scale of from one to four miles per inch, at a cost per square mile ranging from $8 for the flat plains, to $20 for the less rugged mountain regions. The area that would be mapped is about 40,000 sq. miles, and the Government would pay half the cost of the work; the total expense being estimated at about $500,000.

Four types of locomotives of the Pennsylvania R. R. were tested for speed this week over a measured mile on the Jersey meadows, with the purpose, it is said, of selecting a type for hauling fast trains to the World's Columbian Exposition. The engines were as follows: a Baldwin four-cylinder compound with 6½-ft. drivers; the English three-cylinder compound with 6¼-ft. drivers; a Schenectady engine with 6½-ft. drivers, and a Pennsylvania R. R. engine, built at Altoona, with 6½-ft. drivers. Each engine hauled two cars. The speed record for the one mile was as follows:

	Seconds.	Mls. per hr.
Baldwin engine	63	57.1
English engine	65	55.4
Schenectady engine	53	67.9
Pennsylvania engine	47	76.6

Another of the engines built by the company in its own shops is said to have made a measured mile in 45 seconds, or at the rate of 80 miles per hour.

Public water supplies in many sections of the northeast are reported as alarmingly low. Warnings against waste of water in Philadelphia have been officially issued, and in the Schuylkill Valley and elsewhere in Pennsylvania water famines are more or less threatening. In Connecticut, eastern New York and in the Passaic watershed of New Jersey the water is said to be low.

The water rate war in Denver, Colo., is to be continued six months longer, according to the "Republican" of that city. It is said that the two rival companies have each been furnishing water free for the past six months and that they propose to do it for six months more. As was remarked when commenting upon this rate war some weeks ago, the people of Denver will eventually be called upon to make good the cost of this fight.

The Hennepin Canal reports progress as follows, through Capt. W. L. Marshall, U. S. Engineers: Land condemnation over 5 miles of the line immediately above the mouth of Rock River completed; some work done on the locks and additional surveys made near the mouth of Rock River. The total amount of money available is $963,705; up to June 30, 1892, $36,900 had been expended, and the total cost of the work is estimated at $6,925,960.

The Capitol at Washington is being newly sewered and improved in its ventilating system, in accordance with the recommendation of the committee of experts appointed last winter. This committee was composed of Col. George E. Waring, Dr. A. C. Abbot and Col. John S. Billings, Assistant Surgeon-General, U. S. A. The new work will be completed by December next.

The Chief of Ordnance, U. S. A., Gen. D. W. Flagler, in his annual report says that his department will have completed by the end of this year, fifteen 8-in., eight 10-in., and three 12-in. seacoast guns. The accuracy of the new guns tested has been very great, especially the 8-in. The new 12-in. breech-loading mortar, cast iron, hooped with steel, has been fired 364 times, and is adjudged satisfactory.

The Western Railway, of Cuba, has been acquired from the Cuban company by the Western Railway of Havana Co., of London. The first portion of the line was opened about 20 years ago, and the railway has been extended until it is now about 100 miles long. Messrs. James Livesey & Son, of London, the engineers, have recently made a thorough examination of the property. The gage is 4 ft. 8½ ins., the curves and grades are moderate, and ,with the exception of 2

miles, the line is laid with steel rails weighing 62½ lbs. per yd. The terminal station at Havana is a substantial building, and the 23 other stations on the line are all in fair condition, and are provided with the necessary freight sheds, water tanks, trackmen's houses, etc. The rolling stock is sufficient for the present traffic. The line at present terminates at a small station—Puerto de Golpe—and an extension of 10 miles to Pinar del Rio, the capital of the province, is necessary to complete the company's system. From this extension satisfactory receipts are anticipated.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

PENNSYLVANIA.—It is said that engineers of this company have recently surveyed a line across the mountains from William Penn or Girardville, in Schuylkill Co., to which point the Company is now constructing a short line from Shenandoah to Mt. Carmel, the terminus of a branch of the Northern Central. The country is a rough one and the proposed road would necessarily have heavy grades, but it is believed that it will be built, as it would form an important line between two branches of the Pennsylvania now separated by only a few miles.

BAIE DES CHALEURS.—It is announced that the 60 miles of this Canadian road now completed will be repaired and that work on a further extension of 20 miles toward Paspebiac, P. Q., will be commenced at once. Pres., J. R. Thibaudeau, Montreal, P. Q.

OHIO SOUTHERN.—This company has informed the Springfield, O., Board of Trade that it is ready to begin work on the proposed extension of its line from Springfield to Lima, O., as soon as the city of Springfield grants it the right of way within its limits.

KISHACOQUILLAS VALLEY.—The contract for the construction of this road has been awarded to E. E. Tennis, Thompsontown, Pa. The company will furnish the rails and the contractor will do all the other work. Work will be commenced at the Reedsville end, and with reasonably fair weather will be completed in about three months.

PORTLAND & RUMFORD FALLS.—The bids recently received for the construction of the branch from Mechanic Falls to the Maine Central R. R. have been declared null, owing to the decision of the company to change the route. New bids will probably be invited.

Projects and Surveys.

STEELTON & MIDDLETOWN.—It is stated that a private corporation has been organized to build a railway from Steelton to Middletown, Pa. Surveys have been completed.

BEAVER MEADOW, HAZLETON, MAHANOY & SHENANDOAH.—This company has been chartered in Pennsylvania with a capital stock of $150,000 to build a railway 25 miles long. Among the incorporators are A. Markle, Hazleton, Pa., A. P. Blakeslie, Delano, Pa., and P. J. Ferguson, Shenandoah, Pa.

WHITE LAKE.—This company has been organized to build that portion of the Philadelphia & New England R. R., previously mentioned, from Monticello, N. Y., toward Jeffersonville, N. Y.

Southern.—Existing Roads.

CHICKASAYHA & JACKSON.—E. W. Robinson, of Bucatunna, Miss., writes us that this road is projected to run from the Chicksayha River, Wayne Co., Miss., to Jackson, Miss., a distance of 12 miles. Five miles are now graded and track will be laid by Dec. 1, and the entire 12 miles are to be completed by Feb. 1. The road will be standard gage and its principal business will be in logs and lumber. It will do only a freight business at present. The contractor is D. O. Guyunn, Bucatunna, Miss. Pres., Geo. W. Robinson, East Orange, N. J. Ch. Engr., W. F. Lee, Pensacola, Fla.

WINSTON & BONE VALLEY.—This railway is now completed from Winston to Phosphoria, Fla., 21 miles. The total projected length of the road is about 60 miles, included in which are spurs to Bone Valley, 10 miles; Pebble, 10 miles; and Pebbleville, 16 miles. Its principal business will be in lumber, phosphate, stone and vegetables. Pres., J. E. Griffin, Winston, Fla. Ch. Engr., T. L. Morton, Sanford, Fla.

OCONEE & WESTERN.—A. E. Hachfield, of New York, Pres. of this road, writes the "Manufacturers' Record" that contracts will soon be let for building the road from Rocky Creek to Dublin, a distance of 8½ miles, to be completed by Jan. 15, 1893.

SOUTH FLORIDA.—Surveys are reported in progress for a line from Blue Springs to High Springs, Fla.

ROANOKE, FINCASTLE & CLIFTON FORGE.—An engineering corps will soon begin a preliminary survey north from Fincastle to the Chesapeake & Ohio Ry. The grading of this road between Fincastle and Cloverdale, Va., a distance of 11¼ miles, is about finished, and the route between Cloverdale and Roanoke will soon be surveyed. Negotiations are said to be pending for the completion of the entire line from Roanoke to some point on the Chesapeake & Ohio Ry.

WEST VIRGINIA CENTRAL & PITTSBURG.—The engineers of this company have completed the surveys for the line from Mingo, W. Va., to the head of Clover Creek, Pocahontas Co., W. Va. They report that they have made locations for four tunnels with an aggregate length of 3,000 ft., the longest tunnel being 1,400 ft. All four of these are within a distance of about two miles, and are between the headwaters of the Tygart's Valley River and the headwaters of Clover Creek, in Pocahontas Co. It is stated that the route which is being surveyed is the first practicable one which has been found, and it passes through a very heavy and extremely rough country, and a railway built along it will be very expensive.

OWENSBORO, FALLS OF ROUGH & GREEN RIVER.—The contractors, R. R. Hathaway & Co., Owensboro, Ky., have about five miles of track laid on the 16-mile extension to Horse Branch, Ky. The entire extension will be completed early in the spring of 1893.

FAIRMOUNT, MORGANTOWN & PITTSBURG.—This line from Morgantown, W. Va., to Uniontown, Pa., is expected to be completed early in January, 1893. The road is already completed and in use from Uniontown to Smithfield, Pa., and work on the remainder is being pushed. The first 4½ miles north of Cheat River is almost completed so far as the grading is concerned, with the exception of a tunnel 3,000 ft. in length at Morris Cross Road, which may be the cause of some delay, although every effort is being made to complete it promptly. Messrs. Lane Bros., who have the contract for 6½ miles north of Morgantown, have the heaviest work along the line, and have doubled their forces and promised to have the work completed early in November. Work on the bridge over Cheat River is being carried forward very satisfactorily, the piers being above the water and the masonry work almost out of danger of floods. This bridge will be of steel, five spans, 125 ft. long each. It is estimated now that it can be completed in two months with fair weather. The aim of the engineers is to get all the grading done before extreme cold weather sets in, it being possible to carry the tracklaying forward no matter how cold it gets. Stone ballast is being broken all along the line, and it is intended to begin tracklaying from the Morgantown end in about ten days.

FLORIDA NORTHERN.—This company has made application for a charter to build a railway from Hart's Road, Fla., to Savannah, Ga. This is probably the extension of the Jacksonville, Tampa & Key West R. R. before noted.

Projects and Surveys.

LOCKHART SHOALS.—It is stated that negotiations are now pending for building at an early date this proposed railway from Jonesville, S. C. to Lockhart Shoals, S. C., 14 miles. Pres., C. D. Farrar, Union, S. C. Ch. Engr., Glenn D. Peake, Union, S. C.

CHESTERFIELD & LANCASTER.—J. M. Hough, of Old Store, S. C., writes the "Manufacturers' Record" that this project for the present is a dead issue, and efforts are now being made to have the South & North Carolina R. R. extended from Bishopville to Monroe, N. C. This latter road was formerly known as the Bishopville R. R., but obtained authority from the last legislature to change its name as above and extend its road.

Northwest.—Existing Roads.

DULUTH, MISSISSIPPI RIVER & NORTHERN.—Ch. Engr. W. A. Dafter, Swan River, Minn., writes us that the locating survey for the proposed 20-mile extension of this railway is just completed and that the contract for 10 miles has been let to Donald Grant. The contractor is organizing his force and will begin work at once. The contract for the remaining 10 miles is not yet let. The work is light, with easy grades and curves.

CHICAGO & NEW ORLEANS.—The stockholders of this company, of which A. G. Murray, of Springfield, Ill., is President, and S. S. Barger, of Eddyville, Ill., is Vice-President, held a meeting recently and decided to increase the capital stock from $2,000,000 to $3,000,000. It was also decided to begin work on the road at once, the contract having been let to Oliver Ferguson & Sons, of Evansville, Ind. Sixteen miles of grading have already been completed. The road is to run from Altamont to Mt. Vernon, Ill., and thence to Paducah, Ky., and from Mt. Vernon to Carbondale, Ill., in all 182 miles. It is stated that financial backing has been secured in New York and that the construction of the road is a certainty.

Projects and Surveys.

RAPID CITY, PIERRE & EASTERN.—Chartered in South Dakota to build a railway from Rapid City to Aberdeen, S. Dak., and to such other places as the directors may decide upon. The estimated length of the road is 294 miles and its principal offices will be at Rapid City, S. Dak. Among the incorporators are Virgil T. Price, Myron Willsie and Jas. W. Fowler, all of Rapid City, S. Dak.

Southwest.—Existing Roads.

KANSAS CITY, NEVADA & FT. SMITH.—The general contractor for the extension of this line from Hume, Mo., to Pittsburg, Kan., 53 miles, L. J. Smith, American Bank Building, Kansas City, Mo., will sublet the contracts for the section from Clayton, Mo., to Pittsburg, Kan., 35 miles, at once.

ROCKPORT & HARBOR ISLAND.—A correspondent writes us that under the name of the Aransas Pass Transit Ry., about five miles of the line was graded. No more work will be done unless deep water is secured at Arkansas Pass. This road was projected to run from Rockport to Harbor Island, Tex., ten miles.

Projects and Surveys.

TEXAS SABINE VALLEY.—This proposed railway from Carthage to Center, Tex., noted last week, will be 30 miles long.

Rocky Mt. and Pacific.—Existing Roads.

NORTHERN PACIFIC.—The local papers state that this company is making preparations to straighten its line between the Cascade Mts. and Tacoma and Seattle, Wash. The work will practically result in the building of a new line, which will reduce the distance from Palmer to Tacoma, Wash., about eight miles. The present line will not be abandoned, but will be used for the local business.

COOS BAY, ROSEBURG & EASTERN.—Work which had been abandoned for some time has been resumed on this Oregon railway. The company is doing the work with its own men, and at present has about 75 men at work trimming banks and fixing up the roadbed that was built last season. One pile bridge 1,800 ft. long, is nearly completed, and only one more remains to be put in to make a continuous finished grade of 18 miles. South of Marshfield, Ore., tracklaying started Oct. 10, and will be pushed on to Coquille City, eight miles from the end of last season's work. The location from the Roseburg or eastern end of the line was started Sept. 12, and is being pushed as rapidly as possible.

COLUMBIA & PUGET SOUND.—About four miles of track have been laid on the extension from Maple Valley Station, Wash., northeast, and grading is being rapidly pushed by a large force.

GREAT NORTHERN.—In a recent interview Asst. Engr. John F. Stevens is quoted as follows, in speaking of the progress of work on the Pacific Extension: "About twenty days' work will finish up the grading and bridging on the west side of the mountains and on the east side it will be kept out of the way of the tracklayers. Nearly 2,000 men are employed on the west and 1,500 on the east side. About fifty men a day leave, but we are sending up 300 men a week, just about enough to keep the ranks full. Tracklaying has been resumed on the west side and on the east it should be finished from Wenatchee to the summit in 30 days, so that we should get it connected at the summit by Dec. 1 at the latest. Work on the switchback is going on first rate. The bed is cut right into the mountain, and there is but little cribbing, though there is about a mile of bridging in the seven miles. The grade is not heavy. Every switch is a safety switch, so that if a train should get away, it would stop on reaching the foot of the grade."

SOUTHERN PACIFIC.—It is reported that the contract for the line from San Luis Obispo to Ellwood, Cal., has been let to a Colonel Stone for $1,600,000. There is some very heavy work on the line, no less than seven tunnels, one of which is 3,600 ft. long, being located in the first 16 miles south of San Luis Obispo.

PORTLAND & PUGET SOUND.—The Washington papers report both Pres. J. J. Hill, of the Great Northern, and Pres. S. H. H. Clark, of the Union Pacific, as saying that work will soon be resumed on this line from Portland, Ore., to Seattle, Wash., which is being built in the joint interest of the two companies.

Projects and Surveys.

HELENA & SOUTHERN MONTANA.—Articles of incorporation have been prepared at Helena, Mont., for this company, which is being organized to build the proposed railway from Helena to Dillon, Mont. Samuel Ward, of Helena, Mont., is actively interested in the enterprise.

HARRIMAN & PORT ROYAL.—An official of this company states that its proposed line will be from Harriman, Tenn., to Walhalla, S. C., 185 miles, of which 28 miles have been graded in Georgia and South Carolina. Pres., Alfred E. P. Rockwell, Harriman.

ELECTRIC RAILWAYS.

PROVIDENCE, R. I.—The Union Ry. Co. has been authorized to operate the trolley system on its South Providence line. The joint standing committee on railways has been directed to report what would be the most convenient and feasible route for two cross-town lines, one for the west side and one for the east side, in accordance with certain offers made by the Union Ry. Co. to build such lines.

TONAWANDA, N. Y.—The Buffalo, North Main St. & Tonawanda electric railway is expected to be completed this month. The Field Engineering Co. is doing the electrical work.

SOMERS POINT, N. J.—A company is to be organized to build an electric railway to Atlantic City, 12 miles distant. About $25,000 has been subscribed.

SHAMOKIN, PA.—The Shamokin & Mount Carmel Electric Ry. Co. has been incorporated, with a capital stock of $100,000, of which $10,000 is paid in. Pres., E. C. Hamilton.

CHICAGO, ILL.—The Chicago City Ry. has contracted with the Westinghouse Electric & Mfg. Co., of Pittsburg, Pa., for the electrical work on its crosstown lines on the South Side. The South Side Ry. Co. has applied for permission to adopt electric traction on several crosstown lines.

ST. LOUIS, MO.—The Connecting Electric Ry. Co. has been incorporated by J. D. Horseman, F. W. Raeder and George Murch; capital stock, $20,000.

TACOMA, WASH.—The Tacoma & Seattle Rapid Transit Ry. Co. proposes to build an electric line between the two cities, and is having surveys made. Mr. John Snyder, of Tacoma, is one of the promoters.

TRENTON, N. B.—The people of Trenton, Waterville, Stellarton, New Glasgow and other mining towns in that vicinity are in favor of an electric railway from Trenton to Westville. B. Huntsman is now making a survey for it, and it is understood that work will be begun on the railway very soon.

ELEVATED RAILWAYS.

PHILADELPHIA, PA.—The Quaker City Elevated Ry. Co. has received proposals from Sparks & Evans, John A. Kelly, J. J. Ryan, C. A. Porter, P. S. Hart, P. McManes and E. F. Cloud, of Philadelphia; John Nolan, of Reading, Pa.; Grattan & Jennings, of New York, and A. B. Rorke. The work for which the bids were offered is the foundation of the road on Market St., from Front to 13th St., for which plans have been submitted to the Department of Public Works for approval and for which permits are to be asked. The foundations are to be of brick and concrete and will range in depth from 7 to 17 ft. The company has applied to the city authorities for a permit to open Front St. from Market St. north, for foundation work on the Northeastern line. The engineers are considering plans for getting round the City Hall. The curve will bring the line close to the sidewalk along the Wanamaker west front, as there must be no interference with the cable line track. The Department has practically approved the Market St. plans as far as the Schuylkill, but the work which is now to be put in hand extends only to 13th St. The next move will be to obtain a permit for extending the elevated structure up North Front St., for which plans are now in course of preparation. In order to prevent the foundations of the City Hall curve from interfering with the substructures of the city, the company proposes to construct a subway for the water mains, gas pipes and conduits. Pres. and Gen. Man., Carl Buchholz; Cons. Engr., Herman Haupt.

CHICAGO, ILL.—The Elevated Terminal Ry. Co. has been incorporated to build an elevated terminal loop; capital stock, $7,500,000; Walter C. Gunn; John H. Miller, Andrew Gillespie, Paul Brown and William G. Adams.

HORSE AND MOTOR RAILWAYS.

NEWARK, N. J.—The contract for rebuilding the Newark & Orange street railway has been awarded to Wm. P. Craig, of East Orange, N. J., and is being pushed rapidly forward. The track will consist of 9-in. girder rails, spiked to ties laid 30 ins. apart c. to c.; 24-in. fish plates are used and fastened with eight 1-in. bolts.

HAZLETON, PA.—The Beaver Meadow, Hazleton, Mahanoy & Shenandoah Street Ry. Co. has been organized, with a capital stock of $150,000, of which $15,000 is paid in; Pres., A. Markle.

ST. LOUIS, MO.—The Merchants' Terminal, Union Depot & Compton Heights Ry. Co., has applied for a franchise. The line will be in the interest of the Lindell Ry.

DENVER, COLO.—The Park Hill motor line will be extended about a mile to Elmwood.

HIGHWAYS.

NEW YORK.—Proposals for improving certain highways in Jamaica, and for grading, regulating and macadamizing the South plank road, Springfield road, and Locust Ave., will be received until Nov. 14 by the commissioners appointed by the Board of Supervisors of Queens Co.

NEW JERSEY.—The improvement of the road from Highland Park to Metuchen is now under way, also the work on the Madison Township road. There will be not less than ten miles of macadam road built in Middlesex Co. before December, at a cost of about $60,000, of which expense the county taxpayers will pay two-thirds and the state and property owners the other third. The work on the county road from Holly's Corner to South Plainfield is also under way.

WASHINGTON.—The King Co. authorities have commenced condemnation proceedings against the Seattle & Walla Walla Trail & Wagon Road Co., for the purpose of securing property for the opening of a public road. The complaint sets out that the territory lying between North Bend eastwardly a distance of 22 miles to Snoqualmie pass in the Cascade mountains is thickly inhabited and that the only means of travel is over a certain trail and wagon road known as the "Snoqualmie pass trail," operated by the defendant. It was constructed in 1883, and the county officials set forth that it is wholly impassable in view of fallen timber, washouts, etc., and it is intended to open, lay out and maintain a public road upon this route.

OHIO.—Proposals will be received until Nov. 25 by Henry J. Caren, County Auditor, Columbus, for the improvement of 3d. Ave. from the Olentangy River west to Ashland Ave., a distance of 8,051 ft. The roadway is to be opened and graded throughout the entire distance and to be 60 ft. wide, with two sidewalks each 15 ft. wide, and a roadway 30 ft. wide. It is to be macadamized and is to have one line of 4-in. curb on each side of the 30-ft. roadway. The plans, profile and specifications are on file in the office of the County Surveyor. The estimated amounts are as follows: 52,903 cu. yds. of excavation; 16,200 ft. of straight curb; 700 ft. of circle curb; 7,704 cu. yds. broken stone; 5,666 sq. yds. block gutter; 16,200 ft. of 6-in. drain tile; 6 sewer drops, and 480 ft. of 18-in. sewer pipe.

BRIDGES, TUNNELS AND CANALS.

ROCHESTER, N. Y.—The bids recently received for the stone and arch bridge at Court St. were all above the amount of the appropriation, and the Common Councils will be asked to increase it to $150,000.

LANSING, MICH.—Bids will be received until Nov. 21 for building the iron work of the bridge over Grand River at this place. Cy. Engr., E. O. Sellers, Lansing, Mich.

LA CROSSE, WIS.—A new iron bridge, to cost $3,337, will be built at this place.

WATER-WORKS.

New England.

BLAINE, ME.—A water supply is wanted, and a village may be incorporated, or a company organized to secure it, the town not being willing to undertake it.

SWANTON, VT.—It is said that the village charter will be amended so water may be furnished to fire district No. 2.

GREENFIELD, MASS.—Land for a reservoir on Leyden Brook has been bought.

WORCESTER, MASS.—Cement lined pipe will be replaced by 6 and 8-in. cast iron on quite a number of streets.

Middle.

ALBANY, N. Y.—Bids for 1,730 lengths of 4 to 24-in. pipe are wanted.

DEPEW, N. Y.—The officers of the town of Lancaster, in which this new village is located, have granted a franchise to John A. Spoor, Henry W. Box, Geo. Urban, Jr., and others.

MAYVILLE, N. Y.—The bids for works have been returned unopened, and new bids will be received on the basis of a supply from driven wells, instead of an open well, and with May 15, 1893, as the date for completion.

NIAGARA FALLS, N. Y.—Nov. 15 the people will vote on a proposition to lay new mains at a cost of $35,000.

SYRACUSE, N. Y.—Specifications for the distributing reservoir in connection with the new works will be ready for bidders soon. W. R. Hill, Engr.

ALTOONA, PA.—Plans and specifications for an impounding reservoir have been approved by the Council Water Committee.

JERSEY CITY, N. J.—The Board of Street and Water Commissioners have passed a resolution directing the Clerk of the Board to advertise for proposals, to be received Nov. 14, for a new water supply on the basis outlined last week in these columns. It has been reported that this resolution must be approved by Mayor Wanser. News of such approval has not yet been received.

COATESVILLE, PA.—Investigations for a new supply are being made.

ERIE, PA.—The Commissioners of Water-Works have recommended a new water supply, to be secured by extending an intake into Lake Erie at cost of about $270,000.

KNOXVILLE, PA.—It is reported that works will be built by the Lower St. Clair, Knoxville & Allentown Water Co., to supply Knoxville, Beltzhoover and Lower St. Clair, suburbs of Pittsburg, now supplied by the Monongahela Water Co., of Pittsburg. Edward L. Matthews, Philadelphia, is said to be interested. There will probably be a pumping station.

SOMERSET, PA.—The Town Council has directed the Burgess to have plans and specifications for works prepared.

TIONESTA, PA.—The Tionesta Water Supply Co. has been incorporated; $5,000; Treas., A. B. Kelly.

WESTFIELD, PA.—Nov. 8 the people will vote on bonding the borough for $16,000 for works.

Southern.

NORFOLK, VA.—The Tunis Lumber Co. are reported as wanting bids for two duplex pumps, 3,000 to 4,000 ft. of 6, 8, 10 and 12-in. cast iron pipe, hydrants and valves.

ATHENS, GA.—The contract for city works has been let to Mr. Howard Neeley, of Chattanooga, for $118,000. This includes two 1,500,000-gallon pumps, a 150-ft. stand-pipe, 18 miles of 6 to 18-in. mains, 130 hydrants and a 1,000,000-gallon filtering plant.

DE LAND, FLA.—Bids for erecting a part of a system of works are wanted until Dec. 1. L. E. Spencer, Chn. Fire & Water Com.

ATHENS, TENN.—It is reported that there is a move for works here. The Athens Mining & Mfg. Co. own a plant.

CLEVELAND, TENN.—By a fair majority the people voted Oct. 29, to issue $50,000 6% 30-year bonds, to build works.

MORRISTOWN, TENN.—Works are again talked of.

North Central.

CLEVELAND, O.—Bids will be received until Nov. 9 for four 6½ × 16-ft. steel boilers. R. R. Herrick, Dir. Pub. Wks.

GREENVILLE, O.—Water bonds to the amount of $80,000, are to be issued for the proposed new works.

SPRINGFIELD, O.—There is talk of a new 10,000,000-gallon pump.

EDINBURG, IND.—It is reported that specifications for $27,000 works are to be made by Geo. McIntosh, Bloomington, the supply to be from the Sangamon River, from a point about two miles inside the village limits.

ROODHOUSE, ILL.—Works are again under discussion.

Northwestern.

OELWEIN, IA.—Works are being discussed.

PANORA, IA.—A contract for works has been let, and construction has been started.

BLOOMINGTON, NEB.—Works are projected, with a likelihood of being built, reports indicate.

WAKEFIELD, NEB.—The officials have decided not to contract for works, it is said.

SIOUX FALLS, S. DAK.—It is reported that a stand-pipe is projected.

PHILLIPSBURG, MONT.—A franchise for new works has been awarded to the Phillipsburg Water Co., which owns a small plant here. Water will be obtained from a new source, new mains will be built and 15 hydrants will be rented at $112.50 each per year.

Southwestern.

COLUMBIA, MO.—Bids for a franchise are wanted, as stated in our advertising columns.

VAN BUREN, ARK.—It is reported that a 30-years' franchise will be granted, which calls for 36 hydrants at a rental of $90 each; and 1,000,000 to 2,000,000-gallon reservoir, the supply to be from Lee's Creek, and the works to be in operation within eight months.

EL PASO, TEX.—The Council wishes bids for works. A private plant is in operation.

GALVESTON, TEX.—Plans for new works will be made by Engr. W. Kiersted, Kansas City, Mo.

SAN ANTONIO, TEX.—Bids are wanted until Nov. 25 for constructing works for the Headquarters Department of Texas, and San Antonio Quartermaster's Depot, Texas. G. B. Dandy, U. S. A.

Pacific.

TACOMA, WASH.—The Board of Public Works has reported upon a supply for the water front of the city.

CORVALLIS, ORE.—G. E. Waggoner informs us that he thinks the city will buy the company works, add a new pump, mains and stand-pipe or reservoir at an estimated cost of $30,000.

TEHACHAPI, KERN CO., CAL.—The Tehachapi Light & Water Co. has been incorporated; $25,000; Directors, W. T. F. Smith, D. W. Madden and others.

LOS ANGELES, CAL.—Bids for a 4,000,000-gallon high duty pumping engine, to supply the hill section of the city will be received until Dec. 1. Wm. Mulholland, Supt. City Water Co. It is reported that the City Water Co. has bought out the Citizens' Water Co., and that the latter had for some time been in the hands of Receiver J. C. Kays. Also that the City Water Co. recently offered to sell its property, including the works of the Crystal Springs Land & Water Co., and the East Side Spring Water Co., to the city for $2,591,000.

MODESTO, CAL.—Nov. 19 the people will vote on issuing $85,000 of bonds for water and sewerage systems. Works were built by a company in 1876.

SAN LUIS OBISPO, CAL.—It is reported that the people will vote on issuing $120,000 of bonds to build works. Works were built by a company in 1874.

VALLEJO, CAL.—There is a probability that the works owned by Mrs. Remi Chabot will be bought by the city.

VENTURA, CAL.—The Town Board of Trustees is considering the building of works, and Cy. Engr. Powers has reported on the subject. Works were built in 1882 by a company.

LOGAN, UTAH.—The Council has adopted a recommendation from the Committee on Water-Works to the effect that an 18-in. wooden pipe be laid from the canal to the Agricultural College, and iron pipe from the main part of the city, at an estimated cost of $37,000.

SALT LAKE CITY, UTAH.—The South Side Water Co. has been incorporated; $500,000; Pres., O. J. Salisbury; Gen. Man., J. B. Walden; Secy., Francis Hall; Treas., W. S. McCormick. The company has a franchise wich allows it to lay mains in the country between Thirteenth East and the Jordan River, and Tenth South to Twelfth South Sts.

Canada.

ORILLA, ONT.—Mayor Harvie, Chris. Moore, Geo. Thompson and others have been visiting water-works in other places, preparatory to improving or building works here.

ARTESIAN WELLS.

EL PASO, TEX.—Bids for sinking a well are wanted until Dec. 2. Dan. Kelly, Chn. Artesian Well Co.; B. S. Catlin, Cy. Clk.

IRRIGATION.

NEW COMPANIES.—Larned Irrigating Co., Larned, Kan.; $25,000; to operate ditches in Pawnee and Barton Cos. La Veta Land & Reservoir Co., Denver, Colo.; $1,500,000; Directors, R. Williams, Alex. Latham, and others.

SEWERS.

MILTON, MASS.—At a special meeting Nov. 1 the Committee on Sewerage made a report recommending an appropriation of $5,000 for further investigation.

WATERBURY, CONN.—The Sewer Board has recommended that $7,500 be appropriated for repairs and maintenance of sewers next year, and $25,000 for new work.

ALBANY, N. Y.—The Board of Contract will receive bids until Nov. 7 for a 15-in. vitrified stoneware pipe drain in Myrtle Ave.

BROOKLYN, N. Y.—The Commissioner of City Works will receive bids until Nov. 11 for two sewers.

BUFFALO, N. Y.—The contract for the Norfolk Ave. sewer has been awarded to Thos. McKean, at $34,047.

CARTHAGE, N. Y.—The report of the Engineer for the construction of a system of sewerage for this place recommends three discharges into Black River, and the estimated cost of the work is $40,800. The matter will be voted upon by the people in a few days.

COHOES, N. Y.—The City Clerk has been directed to receive bids until Nov. 15 for the construction of a lateral sewer.

CORTLAND, N. Y.—Chas. C. Brown, Cons. Engr., Schenectady, informs us that at a meeting of the State Board of Health Oct. 27 plans were approved for the sewerage of this village, New Paltz and Saranac Lake. Cortland presented a system of sewage disposal by precipitation of solids in tanks by chemicals, the effluent to run into a stream near by, for the present at least. It is probable that some other plans requiring sewage purification will be shortly presented.

NEWBURG, N. Y.—The Board of Aldermen is considering a resolution authorizing the Sewer Committee to petition the Legislature for authority to construct a trunk sewer to relieve the West End and to issue bonds to pay for the same.

NIAGARA FALLS, N. Y.—The time for receiving bids for the trunk sewer has been extended to Nov. 25. The sewer will consist of an 8-ft. tunnel about 5,000 ft. long and 45 ft. below the surface. E. Z. Burns, Cy. Engr.

ROME, N. Y.—The contract for the Washington St. storm-water sewer has been awarded to Eldridge & Fogg, Mt. Vernon, at $7,505.

WATERLOO, N. Y.—Plans for a system have been submitted by Samuel D. Backus, Canandaigua.

CHESTER, PA.—The Committee on Sewers will receive bids until Nov. 7 for two sewers.

PITTSBURG, PA.—The Council has voted in favor of several additional sewers.

READING, PA.—At a meeting Oct. 27, the special committee on house sewage voted to adopt the report of Col. Geo. E. Waring, which was received July 15 last. The report recommends the disposal of sewage by broad irrigation, and mentions the poor house farm, which the report says would be greatly benefitted by the fertilizing ingredients of the sewage, for the disposal plant. It was roughly estimated that the pipes to carry away the sewage and land improvements would cost about $125,000. The secretary was directed to get from the City Engineer an accurate estimate of the cost, exclusive of that part which would be paid for by frontage tax, and present it at a meeting of the committee, when a report will be submitted to a citizens' meeting and councils.

HAGERSTOWN, MD.—Plans for the proposed sewerage system have been prepared by Col. Delafield, Engr. of the Lewis-Mercer Construction Co. The plans will be inspected by the Mayor and Council, and if approved will be submitted to a vote of the people.

PARKERSBURG, W. VA.—The City Council has voted in favor of an 18-in. sewer, with 6-in. laterals, in one street, and bids will soon be asked for the construction.

CHARLESTON, S. C.—The Board of Aldermen has adopted the resolutions recommending that $3,000 be appropriated for surveys and plans for a system of sewerage.

NASHVILLE, TENN.—The Board of Public Works has directed that bids be asked for the extension of the Spruce St. sewer.

CLEVELAND, O.—The Board of Control will receive bids until Nov. 9 for a sewer in Pearl St. Plans have been prepared for sewers in six streets.

DOWAGIAC, MICH.—The Common Council has voted in favor of a sewer in Pennsylvania St.

GRAND RAPIDS, MICH.—The City Engineer is preparing estimates for a 4 or 5-ft. trunk sewer to extend from North St. to the river, along the line of the big ditch.

MARINETTE, WIS.—At a recent meeting of the City Council plans prepared by E. L. Shaw, Cy. Engr., for a general sewerage system were adopted. The question of bonding the city to construct the mains is to be submitted to the voters.

CHICAGO, ILL.—The City Council has ordered the construction of the Robey St. sewer to cost about $225,000. This sewer will traverse the town of Lake from north to south, commencing at 40th St. and ending at 87th St. It will drain all the territory between Ashland and Western Aves., and prevent the inundation of that territory.

KANSAS CITY, MO.—Wm. Taylor, to whom the contract for the completion of the O. K. Creek sewer was awarded, as noted in our issue of last week, refuses to complete the sewer because of alleged discrepancies between the ordinance and the contract, and the work will be readvertised.

OMAHA, NEB.—The Board of Public Works will receive bids until Nov. 11 for sewers in two districts.

GALVESTON, TEX.—W. Kiersted, Kansas City, Mo., has been engaged by the city to prepare plans for a sewer system, and is now in Galveston.

HOUSTON, TEX.—The Council has voted to receive bids for sewers in two sewer districts.

DENVER, COLO.—Estimates have been submitted for sewers in West Denver sewer district No. 2. The cost is placed at $116,250.

GREAT FALLS, MONT.—A contract has been awarded to Mark Tuck, at $18,776. Other bids were as follows: McKay Bros., $21,498; M. S. Parker, $32,273; H. B. Palmer, $26,873.

MODESTO, CAL.—A special election will be held Nov. 19 to vote on the issue of bonds for $85,000 for the construction of sewers and water-works.

STREETS.

NEW HAVEN, CONN.—The proposed paving of Ashman St. is estimated to cost $23,500.

ALBANY, N. Y.—The Board of Control will receive bids until Nov. 7 for paving Maiden lane with granite blocks. The work will include excavation, filling, granite curb, etc.

ALFRED, N. Y.—The citizens of the village are preparing to macadamize the streets. Dunham & Boughton, Plainfield, N. J., are preparing estimates.

BROOKLYN, N. Y.—The Commissioner of City Works will receive bids until Nov. 10 for grading and paving three streets with cobblestones and one with Belgian blocks, and until Nov. 11 for grading and paving one street with cobblestones.

BUFFALO, N. Y.—The Street Committee has reported in favor of paving in six streets with asphalt.

NEW YORK N. Y.—The Commissioner of Public Works will receive bids until Nov. 10 for eight contracts for flagging, curbing, grading, etc. The Board of Estimate has been requested to provide $3,500 for the payment of additional engineers to lay out proposed new streets.

SYRACUSE, N. Y.—The contract for paving South Salina St. with Trinidad Lake asphalt has been awarded to W. H. Gallup, at $54,114. The following bids were received for paving in two streets with vitrified brick; W. H. Gallup, Syracuse brick, $15,085; J. M. Mack & Co., Syracuse brick, $13,937; W. G. Sprague, Syracuse brick, $14,660; Callaway, Rann & Co., Onondaga Brick Co.'s brick, $11,737.

NEWARK, N. J.—Bids will be received until Nov. 7 for the improvement of Forrest St., in the township of Kearny. David Young, Township Surveyor.

CLEVELAND, O.—The Board of Public Works will receive bids until Nov. 23 for about 18,400 sq. yds. of wood paving on the iron portions of the Central and Pearl St. viaducts.

DAVENPORT, IA.—Paving bonds for $71,000 have been sold.

SEDALIA, MO.—The City Engineer has been directed to prepare estimates for the paving of Third st, with asphalt, and the Committee on Streets will soon receive bids for doing the work.

SOUTH OMAHA, NEB.—The Committee on Streets will soon ask for bids for paving L St. with vitrified brick.

ELECTRICAL.

GENESEE, N. Y.—The Board of Aldermen is reported as considering the advisability of advertising for the construction of a municipal plant.

LEXINGTON, VA.—Lester H. Latham, Baltimore, Md., is president of the Lexington Electric Light & Power Co., recently organized to establish an electric light plant at this place.

WELLSBURG, W. VA.—The Wellsburg Electric Light, Heat & Power Co. will increase its capital stock to make additions to its plant.

CHESTER, ILL.—J. D. Gerlach is interested in a proposed plant to supply this and adjacent towns with electric light. The plant is estimated to cost $16,885, and will be both arc and incandescent. This city is reported ready to contract for 23 arc lights.

KANSAS CITY, KAN.—The City Council has passed the ordinance accepting the proposition of the Fort Wayne Electric Co. to construct a plant for the city, referred to in our issue of Oct. 20, and a special election will be held in December at which the people will vote on the proposition. The vote of the Council was seven to three.

SOUTH OMAHA, NEB.—An electric light plant will be put in by a company recently organized by J. A. McShane, W. A. Paxton and E. A. Cudahy.

HEARNE, TEX.—The Hearne Electric Light Co., which we noted as organized in our issue of Oct. 20, is reported as receiving bids for the construction of a plant.

NEW COMPANIES.—Eliot Falls Electric Light Co., Natick, Mass.; $30,000; Pres., A. D. Richards; Treas., A. E. Appleyard. United Columbian Electric Co., Camden, N. J.; $800,000; A. G. Hetherington and C. W. Kennedy, Philadelphia, Pa. Hyndman Electric Co., Hyndman, Pa.; $15,000; Treas., J. K. White. Columbia Light & Power Co., Portland, Me.; $200,000; I. C. Wyman, J. H. Wheeler, Jr., I. C. Atkinson. Consumers' Light & Power Co., Little Rock, Ark.; $200,000; Pres., H. G. Allis; Treas., G. R. Brown. Suburban Electric Light & Power Co., St. Louis, Mo.; $10,000; W. S. Simmons, Walter Krausneck, Gus. George. Magnolia Light, Heat & Power Co., Warrensburg, Mo.; $20,000; W. P. Hurt, A. M. Zimmerman, J. T. Cheatam. Green River Electric Light & Power Co., Green River, Wyo.; $12,000; Pres., T. S. Taliaferro, Jr.; Man., T. J. Wyche.

CONTRACT PRICES.

SEWERS.—Negaunee, Mich.—We have received from C. R. Wightman, Engr. in Charge, a copy of the bids received for the main sewer, the contract for which we noted last week as awarded to Wolf, King & Co., at $32,542. The bidders were as follows: (1). G. J. Anderson, Superior, Wis.; (2) Winston & Rousser, Minneapolis, Minn.; (3) Wolf, King & Co., West Superior, Wis.; (4) Kirkland & Starkey, St. Paul, Minn.; (5) Campbell & Foley, Menominee, Mich.

Items.	(1)	(2)	(3)	(4)	(5)
24-in. pipe, 9,600 ft., per lin. ft.	$ 2.35	$ 3.35	$ 2.25	$ 2.41	$ 2.85
20-in. pipe, 900 ft. per lin. ft.	2.00	2.40	2.35	3.00	2.35
18-in. pipe, 1,050 ft., per lin. ft.	1.60	1.71	1.70	1.55	2.10
15-in. pipe, 2,500 ft., per lin. ft.	1.37	1.45	1.35	1.40	1.25
6-in. pipe, 375 ft., per lin. ft.	.75	.75	.50	.80	.80
Catch basins, 10, each	.35.	40.	50.	52.35	48.
Lamp holes, 8, each	.20.	10.	10.	2.40	12.50
Manholes, 20, each	.45.	40.	50.	68.40	45.
Bulkheads, 2 each	.40.	35.	50.	30.	35.

Sewickley, Pa.—We are informed by F. A. Dunham, Engr. in Charge, that contracts have been awarded as follows: Wm. J. Dunn, 6, 8, 10, 12, 15, 18 and 20-in. pipe, 40, 55, 63, 67, 75, 90 cts. and $1 per lin. ft., respectively; 12 and 20-in. cast iron pipe, $2.90 and $4.25; 12, 15 and 18-in. Y's, 65, 90 cts. and $1.25; 4-in. drain tile, 6 cts.; lamp holes, $10 each; manholes, $35; masonry protection wall, $10 per cu. yd.; rip rap stone in place, $2. Walter Patton, 6, 8 and 12-in. pipe, 62, 65 and 73 cts.; 12-in. Y's, $1.33; 4-in. drain tile, 6 cts.; lampholes, $10.29; manholes, $51.75. F. P. Sawders & Co., 6, 8, 10 and 12-in. pipe, 46, 50, 55 and 58 cts.; 8 and 10-in. Y's, 28 and 38 cts.; 4-in. drain tile, 3 cts.; lampholes, $6; manholes, $42; flush tank, $72.

Milwaukee, Wis.—Ten contracts for pipe sewers have been awarded at prices varying as follows: 12-in., $1.07 to $1.65 per lin. ft.; 15-in., $1.24 to $1.80; 18-in., $1.65 to $2.

Boston, Mass.—We publish below the prices of the bids received by the Metropolitan Sewerage Commission for section 28 of the main sewer, in Cambridge. The total bids were printed last week. The bidders were as follows: (1), Chas. G. Crafb, Chelsea; (2), Mellen & McKenzie, Springfield; (3), Chas. Linehan, Cambridgeport; (4), H. P. Nawn, Boston; (5), John Sheehan, Lynn; (6), Metropolitan Construction Co., Boston, (7), Cashman & Juul, Newburyport; (8), Malone & Talient, Everett; (9), Jones & Meehan, Jamaica Plain; (10), National Construction Co., Boston; (11), Christopher McBride, Brighton; (12), John L. Reardon & Co., Brighton.

	Earth excav. and refill.	Masonry.—Brick.	Masonry.—Brick.	Masonry.—Concrete.	Masonry.—Concrete.	Spruce lumber in place.
	6,500 lin. ft.	Am. 1,600 cu. yds.	Port. 600 cu. yds.	Am. 650 cu. yds.	Port. 100 cu. yds.	10 M. ft. B. M.
(1)....	$9.00	$13.86	$14.91	$5.00	$7.00	$40.
(2)....	7.90	16.00	17.00	7.00	9.00	45.
(3)....	8.00	12.50	14.00	3.75	5.00	25.
(4)....	7.50	13.00	14.00	5.00	7.00	30.
(5)....	7.30	12.70	14.50	6.50	7.50	35.
(6)....	7.25	12.67	14.51	5.40	7.25	35.
(7)....	5.75	15.00	18.00	7.00	8.85	34.
(8)....	6.80	12.50	14.75	5.75	7.00	35.
(9)....	7.00	12.00	14.00	5.00	7.00	30.
(10)...	6.27	12.45	13.80	5.00	6.95	30.
(11)...	5.40	13.00	14.50	6.00	7.50	35.
(12)...	5.75	12.15	13.75	5.00	6.50	35.

STREET WORK.—Great Falls, Mont.—The following bids were received for paving Central Ave.: Parker & Armington, vitrified brick on concrete, $3.50 or $4.50 per sq. yd., for one or two courses of brick, respectively; cedar blocks, $3.50 or $3.75 for American or hydraulic concrete; curb, $1.25 or $2 per lin. ft. for sandstone or granite; furnishing and setting ten catch basins, and connecting same with sewer, $2,500. Henry Vogel, brick, as above, $2.55 or $3.20; granite curb, $1.25; basins and connections, $1,200. H. B. Palmer, brick, $4.65 or $5.75; cedar blocks, $3.33; granite curb, $1.50; basins, $1,200. Mark Tuck, cedar blocks, $2.55; granite curb, $1.25; basins, $1,200. McKay Bros., cedar blocks, $2.65; granite curb, $1.35; basins, $1,150.

Galveston, Tex.—The contract for brick curbing has been awarded to Barnes & Pallister, at $18 per 1,000.

DRAINAGE CANAL.—Chicago, Ill.—We are informed by Benezette Williams, Ch. Engr., that the contracts for sections D, E, and F, of the main drainage canal, between Willow Springs and Summit, were awarded Oct. 26 to Ricker, Lee & Co., Galveston, Tex., at the following prices, depending upon whether the large or small sized channel is adopted, this question not having been settled yet; Section D, glacial drift, 20½ and 22½ cts. per cu. yd.; section E, 20¾ and 23 cts.; section F, 21 and 23¾ cts.; rock, 80 cts. This covers about 5,500,000 yds. of glacial drift for the large channel, and 3,500,000 yds. for the small one, and about 50,000 yds. of rock.

IRONWORK.—Brooklyn, N. Y.—The following proposals were received Oct. 14 by Col. O. F. Nichols, Chief Engineer of the Brooklyn Elevated R. R., for building the superstructure of the Fulton Ave. and Fifth Ave. extensions. The contract for the former was awarded to the Edge Moor Bridge Works, Wilmington, Del., and for the latter to Cofrode & Saylor, Pottstown, Pa. The prices are per lb.:

Bidders.	Fulton Ave. Steel. Cts.	Fulton Ave. Iron. Cts.	Fifth Ave. Steel. Cts.	Fifth Ave. Iron. Cts.
Cofrode & Saylor	3.05	3.05	3.05	3.05
Edge Moor Bridge Works	2.98	2.98	3.15	3.15
Carnegie Steel Co.	....	....	**3.05	3.25
Union Bridge Co.	....	....	3.25	3.25
Pencoyd Iron Works	3.14	3.14	3.14	3.14
Cooper, Hewitt & Co.	*3.22	3.22	....	....
King Bridge Co.	3.80	3.80	3.80	3.80
Phoenix Bridge Co.	....	....	3.45	....

* Conditioned upon the terms of contract being made satisfactory.

** Conditioned on time being extended 30 days.

MISCELLANEOUS.

DRAINAGE CANAL.—Chicago, Ill.—The Drainage Board has decided to readvertise for sections A, B and C of the main drainage canal, between Willow Springs and Summit, as the lowest bids were considered too high.

SCRAPER WORK.—Memphis, Tenn.—J. S. M'Tighe & Co. will receive bids for 500,000 cu. yds. of good scraper level work, alluvial soil; fill, 7 to 12 ft.; price, 16 to 24 cts. per yd.

GAS MACHINE.—Benicia, Cal.—Lt.-Col. L. S. Babbitt will receive bids until Nov. 15 for a 500-light Springfield gas machine, with mixing regulator complete, together with 300 burners, the same to be delivered and set up at the arsenal.

RAILWAY SWITCH TRACK AND TRACK SCALES.—Cleveland, O.—The Director of Public Works will receive bids until Nov. 9 for doing necessary grading, ballasting, furnishing ties, rails, etc., and completing a railway switch of standard gage, about 850 ft. long, at West Side pumping station; also for furnishing a standard gage railway track scale of 60 tons capacity, for a platform 36 ft. long, at same place

IRON AND STEEL PIER.—Washington, D. C.—Bids will be received at the Bureau of Yards and Docks, Navy Dept., until Dec. 21 for an iron and steel pier at the U. S. naval coaling station in the harbor of Pago Pago, Samoa. N. H. Farquar, Ch. of Bureau.

CITY HALL.—Jersey City, N. J.—The City Hall Commissioners have been authorized to advertise for bids for the proposed city hall.

GAS COMPANY.—Chicago, Ill.—The Cook County Fuel Gas Co. has been incorporated by Ralph M. Shaw, B. W. Schumacher and Thos. R. Shearer; capital stock, $2,000,000.

DREDGING COMPANY.—Brooklyn, N. Y.—The Riverhead Dredging Co. has been organized for the purpose of dredging and widening the Peconic River. Pres., W. H. Sweezy; Secy., Capt. Benj. S. Hallock.

HUDSON RIVER IMPROVEMENTS.—Albany, N. Y.—The contracts for deepening the Hudson River channel between Coxsackie and Troy to a uniform depth of 20 ft. have been awarded, in accordance with the recommendations of Lt.-Col. G. L. Gillespie, as follows: Edwards, Howlett & Thompson, New York, constructing dikes, $231,302, and dredging, $956,340; Ross & Sanford, New York, rock excavation, $965,000. The entire cost of the work will be about $2,500,000, of which $600,000 was appropriated at the last session of Congress. It is estimated that it will take three years in which to complete the work. We published the bids received for this work in our issue of Oct. 13.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Baldwin Locomotive Works, Philadelphia, Pa., have built three more Vauclain four-cylinder compound engines for the Rio Grande Western. The Cooke Locomotive & Machine Works, Paterson, N. J., have built eight passenger engines for the Newport News & Mississippi Valley and five six-wheel switch engines for the Chicago & Western Indiana. The Rhode Island Locomotive Works, Providence, R. I., have an order for two two-cylinder compound Forney tank engines for the Kings County Elevated, Brooklyn, N. Y.; they will be similar to the one already in service. The Pittsburg Locomotive Works, Pittsburg, Pa., have built six ten-wheel express passenger engines for the St. Louis, Vandalia & Terre Haute; they have cylinders 20 × 26 ins., driving wheels 6 ft. diameter, and weigh 137,000 lbs.

CARS.—The Ohio Falls Car Co., Clarksville, Ind., has an order for four passenger and two combination cars for the Duluth, Mesaba & Northern. Harlan & Hollingsworth, Wilmington, Del., are building 15 cars for the Kings County Elevated, Brooklyn, N. Y. The Indiana Car & Foundry Co., Indianapolis, Ind., is building 500 cars for the Hicks Stock Car Co. The Lebanon Car Co., Lebanon, Pa., is building 300 freight cars for the Pennsylvania & Northwestern. The Billinger & Small Co., York, Pa., is building narrow gage passenger cars for the Cartagena railway, U. S. Colombia. The Houston Car Co., Houston, Tex., has been incorporated by D. D. Coley and N. L. Mills, with a capital stock of $400,000. The Madison Car Co., Madison, Wis., has a number of orders on hand.

STEEL TIES.—The Schoen Mfg. Co., Allegheny, Pa., has nearly completed 18,000 Hartford pressed steel ties for the New York Central. The ties were described and illustrated in our issues of March 12 and April 2.

RAILWAY SHOPS.—The Georgia, Carolina & Northern shops will be located at Abbeville, S. C. The town has donated the land and $15,000 in money.

THE NATIONAL SWITCH & SIGNAL CO., Easton, Pa., will remove to Odenweidertown, Pa., near Easton, and will erect extensive buildings on about ten acres of land.

H. R. WORTHINGTON, New York, N. Y., has put in some new duplex pumps for the Consolidation Coal Co., Frostburg, Md. Steam cylinders, 22 × 18 ins.; plungers, 12½ × 18 ins.; each pump is capable of delivering 1,000 gallons of water per minute to a height of 250 ft., with a steam pressure of 60 lbs. per sq. in.

THE CONGDON BRAKE SHOE CO., Chicago, has removed its general offices from the Monadnock Building, to the works at Fifty-ninth and Wallace Sts., Chicago, and all communications should be sent to that address. The company has a plant for making all kinds of high grade steel castings. Vice-Pres. and Gen. Man., W. D. Sargent.

NEW COMPANIES.—Young & Willover Automatic Railway Block Signal Co., Chicago, Ill.; $600,000; R. B. Kendall, Gordon H. Knott and L. F. English. Hydraulic Brake Co., Jersey City, N. J.; $5,000,000; J. B. Powell, of New York; T. J. Montgomery, of Larchmont, N. Y., and R. W. Elliott, of Jersey City, N. J. Maryland Surveying Co., Baltimore, Md.; $35,000; O. C. Martenet, R. W. MacCubbin, Jr., and Dr. B. F. Phillips. Northern Central Construction Co., East St. Louis, Ill.; $200,000; E. H. Webster, and T. E. Irwin. Mable Automatic Car & Self Coupler Co., Fort Collins, Colo.; Wm. Mable, A. Aikin and J. A. C. Kaissook. Cleveland Steel Casting Co., Cleveland, O.; $100,000; N. P. Bowler, J. V. Kennedy and C. A. Parsons. St. Jo. Asphaltum Co., San Antonio, Tex., $200,000; W. M. Holmes and S. B. Hanway.

CURRENT PRICES.

RAILS.—New York: $30 at eastern mills, $30.75 at tidewater; old rails, $16.50 to $17 for pig iron and $14 to $14.50 for steel. Pittsburg: $30; old rails, $19.50 to $20 for iron and $15 to $16 for steel. Chicago: $31 to $32.50. light rails, $32; old rails, $18.50 for iron, and $12.50 to $14.25 for steel.

TRACK MATERIAL.—New York: steel angle bars, 1.6 to 1.65 cts.; spikes, 1.9 to 2 cts.; track bolts, 2.4 to 2.6 cts. with square and 2.7 to 2.8 cts. with hexagon nuts. Pittsburg: splice bars, 1.75 to 1.77 cts. for iron and 1.8 cts. for steel; iron and steel spikes, 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 cts. with hexagon nuts. Chicago: splice bars, 1.7 to 1.75 cts. for iron and steel; spikes 2.05 to 2.15 cts.; track bolts, 2.65 to 2.75 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows at Pittsburg: 57½% and 10% and 50% and 16% on black and galvanized butt welded; 67% and 10%, and 60% and 10% on black and galvanized lap-welded. Casing, 55%.

FOUNDRY PIG IRON.—New York: $13.50 to $16. Pittsburg: $13 to $14.25. Chicago: $13.25 to $14.75.

LEAD.—New York: 3.95 to 4 cts.; Chicago: 3.77 to 3.8 cts.; St. Louis: 3.7 to 3.75 cts.

STRUCTURAL MATERIAL.—New York: beams, 2.2 to 2.5 cts. for large lots, and 2.35 to 2.75 cts. for small lots; channels, 2.25 to 2.5 cts.; angles, 1.95 to 2 cts.; tees, 2.3 to 2.75 cts.; sheared iron plates, 1.85 to 2.1 cts.; steel plates, 1.9 to 2 cts. for tank, 2.2 to 2.25 cts. for shell, 2.5 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 2.1 to 2.2 cts. for large lots; channels, 2.1 to 2.2 cts. for large lots; angles, 1.8 to 1.9 cts.; tees, 2.4 to 2.5 cts.; Z-bars, 2 to 2.1 cts.; universal mill plates, 1.75 to 1.85 cts. for steel; sheared steel bridge plates, 2 to 2.1 cts.; refined bars, 1.7 cts. for iron and steel; steel plates, 1.75 to 2 cts. for tank, 2 to 2.25 cts. for shell, 2.1 to 2.35 cts. for flange, 3.5 to 3.75 cts. for firebox, 2 to 2.25 for bridge. Chicago: beams, 2.2 to 2.3 cts.; channels, 2.2 to 2.3 cts.; angles, 1.95 to 2 cts.; tees, 2.2 to 2.3 cts.; universal plates, 2 to 2.1 cts.; steel plates, 1.9 to 2 cts. for tank, 2.2 to 2.3 cts. for shell, 2.5 to 2.6 cts. for flange, and 2.7 to 2.8 cts. for firebox.